CHAPTER 15. REGULATORY IMPACT ANALYSIS

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CHAPTER 15. REGULATORY IMPACT ANALYSIS

15.1 INTRODUCTION

The U.S. Department of Energy (DOE) has determined that energy conservation standards for residential water heaters, direct heating equipment, and pool heaters constitute an "economically significant regulatory action" under Executive Order (E.O.) 12866, Regulatory Planning and Review. 58 FR 51735, Volume 58, No. 190, page 51735. (October 4, 1993). Under 10 CFR part 430, subpart C, appendix A, section III.12, DOE committed to evaluating non-regulatory alternatives to chosen standards by performing a regulatory impact analysis (RIA). 61 FR 36981, Volume 61, No. 136, page 36978. (July 15, 1996). This RIA, which DOE has prepared pursuant to E.O. 12866, evaluates potential non-regulatory alternatives, comparing the costs and benefits of each to those of the chosen standards. 58 FR 51735, page 51741. As noted in E.O. 12866, this RIA is subject to review by the Office of Management and Budget's Office of Information and Regulatory Affairs. 58 FR 51735, page 51740.

Of the four product classes of residential water heaters subject to standards, this RIA concerns only gas-fired storage and electric storage water heaters, which represent the majority of shipments. As described in section 15.2.2, the efficiency level in the chosen standard for gas-fired storage water heaters is level 1 for small rated volume water heaters and level 6 for large rated volume water heaters. The efficiency level in the chosen standard for electric storage water heaters is level 5 for small rated volume water heaters and level 6 for large rated volume water heaters. Of the five product classes of direct heating equipment (DHE), this RIA concerns only gas wall fan DHE and gas hearth DHE, which represent the majority of shipments. The efficiency level in the chosen standard for gas wall fan DHE is level 2, and the efficiency level in the chosen standard for gas hearth DHE is level 1. The efficiency level in the chosen standard for pool heaters is level 3.

DOE identified six non-regulatory policy alternatives that feasibly could achieve the same energy efficiency as the chosen standards for the products that are the subject of this rulemaking. The non-regulatory policy alternatives are listed in Table 15.1.1. DOE evaluated each alternative in terms of its ability to achieve significant energy savings at a reasonable cost, and compared the effectiveness of each to the effectiveness of the chosen standard.

Table 15.1.1 Non-Regulatory Alternatives to National Standards

No New Regulatory Action
Consumer Rebates
Consumer Tax Credits
Manufacturer Tax Credits
Voluntary Energy Efficiency Targets
Early Replacement
Bulk Government Purchases

In addition to the above six non-regulatory policy alternatives, specifically for this rulemaking DOE evaluated the potential impacts of a policy that would allow States to require that electric storage water heaters installed in new homes have an efficiency level higher than the Federal standard (mandated through State building codes). For this policy, DOE further assumed that electric storage water heaters purchased for existing buildings would have to meet the chosen standard level.

15.2 NON-REGULATORY POLICIES

This section describes the method DOE used to analyze the energy savings and cost effectiveness of the six non-regulatory policy alternatives (excluding the alternative of no new regulatory action) for the identified residential water heaters, direct heating equipment, and pool heaters. This section also describes the assumptions underlying the analysis.

15.2.1 Methodology

DOE used its national impact analysis (NIA) spreadsheet models to calculate the national energy savings (NES) and net present value (NPV) associated with each non-regulatory policy alternative. (Chapter 10 of the technical support document (TSD) describes the NIA spreadsheet models.) DOE quantified the effect of each alternative on the purchase of products that meet *target efficiency levels*, which are defined as the efficiency levels in the chosen standards, described above. After establishing the quantitative assumptions underlying each alternative, DOE appropriately revised inputs to the NIA spreadsheet models. The primary model inputs that DOE revised were market shares of products meeting target efficiencies and equipment replacement rates. The shipments of products for any given year reflect a distribution of efficiency levels. DOE assumed that the chosen standards would affect 100 percent of the shipments of products that did not meet target levels in the base case,[a] whereas the non-regulatory policies would affect a smaller percentage of those shipments. DOE made certain assumptions about the percentage of shipments affected by each alternative policy. DOE used those percentages to calculate the shipment-weighted average energy consumption and costs attributable to each policy alternative, of residential water heaters, direct heating equipment, and pool heaters.

Increasing the efficiency of a product often increases its average installed cost. On the other hand, operating costs generally decrease because energy consumption declines. DOE therefore calculated an NPV for each non-regulatory alternative in the same way it did for the chosen standards. In some scenarios, increases in total installed cost are mitigated by government rebates or tax credits. Because DOE assumed that consumers would re-pay credits and rebates in some way (such as additional taxes), DOE did not include rebates or tax credits as a consumer benefit when calculating national NPV. DOE's analysis also excluded any administrative costs for the non-regulatory policies; including such costs would decrease the NPVs slightly.

The following are key measures for evaluating the impact of each alternative.

[a] The base case for the NIA is a market-weighted average of units at several efficiency levels.

- National energy savings, given in quadrillion Btus (quads), describes the cumulative national primary energy savings for products bought during the period from the effective date of the policy (2015 for water heaters and 2013 for direct heating equipment and pool heaters) through the end of the analysis period (2045 for water heaters and 2043 for direct heating equipment and pool heaters).

- Net present value represents the value in 2009$ (discounted to 2010)[b] of net monetary savings from products bought during the period from the effective date of the policy (2015 for water heaters and 2013 for direct heating equipment and pool heaters) through the end of the analysis period (2045 for water heaters and 2043 for direct heating equipment and pool heaters).

- DOE calculated the NPV as the difference between the present value of installed equipment cost and operating expenditures in the base case and the present value of those costs in each policy case. DOE calculated operating expenses (including energy) for the life of the product.

15.2.2 Assumptions Regarding Non-Regulatory Policies

The effects of non-regulatory policies are by nature uncertain, because they depend on program implementation and marketing efforts and on consumers' responses to a program. Because the projected effects depend on assumptions regarding the rate of consumer participation, they are subject to more uncertainty than are the impacts of mandatory standards, which DOE assumes will meet with full compliance. To increase the robustness of the analysis, DOE conducted a literature review regarding each non-regulatory policy and consulted with recognized experts to gather information on similar incentive programs that have been implemented in the United States. By studying experiences with the various types of programs, DOE sought to make credible assumptions regarding potential market impacts. Section 15.3 presents the sources DOE relied on in developing assumptions about each alternative policy and reports DOE's conclusions as they affected the assumptions that underlie the modeling of each policy.

Each non-regulatory policy that DOE considered would improve the average efficiency of new residential water heaters, direct heating equipment, and pool heaters relative to their base cases (which involve no new regulatory action). The analysis considered that each alternative policy would induce consumers to purchase units having the same efficiency levels as required by the chosen standards (the target levels). As opposed to the standards case, however, the policy cases may not lead to 100 percent market penetration of units that meet target levels.

Tables 15.2.1 through 15.2.3 show the efficiency levels stipulated in the chosen standards for the products in this rulemaking. For residential water heaters, these are level 1 for small rated volume and level 6 for large rated volume gas-fired storage water heaters and level 5 for small

[b] The Final Rule for heating products is expected to be published in 2010.

rated volume and level 6 for large rated volume electric storage water heaters. For direct heating equipment, the efficiency levels stipulated in the chosen standards are level 2 for gas wall fan DHE and level 1 for gas hearth DHE. The efficiency level stipulated in the chosen standards for pool heaters is level 3.

Table 15.2.1 Efficiency Levels in Chosen Standards for Residential Water Heaters

Water Heater Product Class	Efficiency Level
Gas-Fired Storage	0.62 EF*; standing pilot; 1.5″ insulation for small rated volume Heat pump WH; 2″ insulation for large rated volume
Electric Storage	0.95 EF; 4″ insulation for small rated volume and Heat pump WH; 2″ insulation for large rated volume

* Energy factor

Table 15.2.2 Efficiency Levels in Chosen Standards for Direct Heating Equipment

DHE Product Class	Efficiency Level
Gas Wall Fan	76% AFUE*; electronic ignition; improved heat exchanger
Gas Hearth	67% AFUE; electronic ignition

* Annual fuel utilization efficiency

Table 15.2.3 Efficiency Levels in Chosen Standards for Pool Heaters

Pool Heater Product Class	Efficiency Level
Gas-Fired	82% thermal efficiency; improved heat exchanger

For the special policy case in which States would impose a regulation that electric storage water heaters installed in new homes would need to meet a high efficiency level than the target level, DOE also assumed that the standard (target) level would apply to water heaters destined for existing homes. DOE assumed that the efficiency level mandated by State building codes would be level 6 (2.0 EF), which represents heat pump water heater technology. The level for existing homes would be level 5 (0.95 EF), as shown in Table 15.2.1 above.

DOE assumed that the effects of non-regulatory policies would last from the effective date of standards—2015 for water heaters and 2013 for direct heating equipment and pool heaters—through the end of the analysis period, which is 2045 for water heaters and 2043 for direct heating equipment and pool heaters.

15.2.3 Policy Interactions

DOE calculated the effects of each non-regulatory policy separately from those of the other policies. In practice, some policies are most effective when implemented in combination, such as early replacement implemented with consumer rebates, or early replacement implemented with bulk government purchases. However, DOE attempted to make conservative assumptions to avoid double-counting policy impacts. The resulting policy impacts are not

additive: the combined effect of several or all policies cannot be inferred from summing their results.

Section 15.3 presents graphs that show the market penetration estimated under each non-regulatory policy for residential water heaters, direct heating equipment, and pool heaters.

15.3 NON-REGULATORY POLICIES

The following subsections describe DOE's analysis of the impacts of the six non-regulatory policy alternatives to chosen standards for water heaters, direct heating equipment, and pool heaters. (Because the alternative of No New Regulatory Action has no energy or NPV impacts, essentially representing the NIA base case, DOE did not perform additional analysis for that alternative.) DOE developed estimates of the market penetration of high-efficiency products both with and without each of the non-regulatory policy alternatives.

15.3.1 No New Regulatory Action

The case in which no new regulatory action is taken with regard to the energy efficiency of residential water heater, direct heating equipment, and pool heater products constitutes the base case, as described in chapter 10, National Impact Analysis. The base case provides the basis of comparison for all other policies. By definition, no new regulatory action yields zero energy savings and an NPV of zero dollars.

15.3.2 Consumer Rebates

DOE considered this scenario in which the Federal government provides financial incentives in the form of rebates to consumers for purchasing energy efficient appliances. This policy provides a consumer rebate for purchasing residential water heater, direct heating equipment, and pool heater products that operate at the same efficiencies as stipulated in chosen standards. In July 2009 DOE announced funding from the American Recovery and Reinvestment Act (ARRA)[1] for State-run rebate programs for consumer purchases of new ENERGY STAR® qualified home appliances.[2]

DOE evaluated consumer rebates using a comprehensive study of California's potential for achieving energy efficiency. The study, performed by XENERGY, Inc.,[c] summarizes experiences with various utility rebate programs.[3] XENERGY's analytical method utilizes curves that estimate the market penetration of a technology based on its benefit/cost (B/C) ratio. DOE consulted with experts and reviewed other methods of estimating the effect of consumer rebate programs on the market penetration of efficient technologies. The other methods, developed after the referenced XENERGY report was published,[4, 5, 6, 7, 8] used different approaches: different economic parameters (e.g., payback period), expert surveys, or calibration of a model with specific program data rather than using generic penetration curves. DOE decided that the most appropriate available method for this RIA analysis was the XENERGY approach of

[c] XENERGY is now owned by KEMA, Inc. (www.kema.com)

penetration curves based on B/C ratio, which incorporates lifetime operating cost savings. DOE adjusted the XENERGY penetration curves based on expert advice founded on more recent utility program experience. Appendix 15-A, section 15-A.2, contains details on how DOE adjusted the curves.

XENERGY's model estimates market impacts induced by financial incentives based on the premise that two types of information diffusion drive the adoption of new technologies. *Internal sources* of information encourage consumers to purchase new products primarily through word-of-mouth from early adopters. *External sources* affect consumer purchase decisions through marketing efforts and information from outside the consumer group. Appendix 15-A, section 15-A.2, contains additional details on internal and external information diffusion.

XENERGY's model equation accounts for the influences of both internal and external sources of information by superimposing the two components. Combining the two mechanisms for information diffusion, XENERGY's model generates a set of penetration (or implementation) curves for a measure. XENERGY then calibrated the curves based on participation data from utility rebate programs. The curves illustrate the increased penetration (i.e., increased market share) of efficient products driven by consumer response to changes in B/C ratio induced by rebate programs. The penetration curves depict various diffusion patterns based on perceived barriers (from low to extremely high)[d] to consumer purchase of high-efficiency products.

DOE modeled the effects of a consumer rebate policy for water heaters, direct heating equipment, and pool heaters by determining the increase in market penetration of target-level products relative to their market penetration in the base case. It did this using the penetration curve from the XENERGY study that best reflect the market barriers faced by each product class. It also noted which curve showed a market share at the product's B/C ratio without rebates that was closest to DOE's predicted 2015 market share of the target-level unit in the base case.

15.3.2.1 Water Heaters

For water heaters, DOE estimated the effect of increasing the B/C ratio via a rebate that would pay part or all of the increased installed cost of a unit meeting the target efficiency level compared to one meeting the baseline level.[e] DOE based the rebate amounts on two large samples of utility and agency rebate programs for water heaters.

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[d] There is also a *no barriers* curve, which is considered a theoretical curve reflecting penetration rates that could not be achieved by an actual program.

[e] The baseline technology for each product class is defined in the engineering analysis, chapter 5, as the technology that represents the basic characteristics of products in that class. A baseline unit typically is one that just meets current Federal energy conservation standards and provides basic consumer utility.

For gas-fired storage water heaters, DOE gathered data on 62 rebate programs initiated by 39 utilities or agencies in States throughout the country. (Appendix 15-A, section 15-A.3.1, identifies the programs.) DOE analyzed consumer rebates for gas-fired storage small rated volume water heaters for a target level of 0.62 EF and for large rated volume water heaters for a target level of 0.77. Thirty-seven of the rebate programs, which involved water heaters of various sizes and efficiency levels, were for units with an EF that met the target (standard) level for small rated volume water heaters (0.62 EF). To represent the rebate level for these water heaters, DOE used the simple average of the rebate amounts in these 37 programs. This average, $56, was 61 percent of the increase in installed cost of $92 for gas-fired small volume storage water heaters that meet the 0.62 target level compared to those at baseline efficiency levels. DOE therefore assumed that a rebate program for gas-fired small rated volume storage water heaters would offer a rebate amounting to 61 percent of the incremental installed cost of the target-level unit versus the baseline unit.

Seven of the rebate programs were for units with an EF that met the target (standard) level for large rated volume water heaters (0.77 EF). To represent the rebate level for these water heaters, DOE used the simple average of the rebate amounts in these 7 programs. This average, $241, was 30 percent of the increase in installed cost of $805 for gas-fired large rated volume storage water heaters that meet the 0.77 target level compared to those at baseline efficiency levels. DOE therefore assumed that a rebate program for gas-fired large rated volume storage water heaters would offer a rebate amounting to 30 percent of the incremental installed cost of the target-level unit versus the baseline unit.

For electric storage water heaters, DOE gathered data on 246 rebate programs developed by 101 utilities or agencies throughout the country. (Appendix 15-A, section 15-A.3.2, identifies the rebate programs.) DOE analyzed consumer rebates for electric storage small rated volume water heaters for a target level of 0.95 EF and for large rated volume water heaters for a target level of 2.0. None of the rebate programs were for units with an EF that met the target (standard) level for small rated volume water heaters, (0.95 EF). DOE therefore selected the 26 rebate programs for electric storage water heaters that required 0.94 EF, reasoning that rebate amounts would be similar for both efficiency levels. To represent the rebates amount for these water heaters, DOE used the simple average of the rebate amounts in these 26 programs. This average, $97, was 73 percent of the increase in installed cost of $132 for electric storage small rated volume water heaters that meet the 0.95 target level compared to those at baseline efficiency levels. DOE therefore assumed that a rebate program for electric storage small rated volume water heaters would offer a rebate amounting to 73 percent of the incremental installed cost of the target-level unit versus the baseline unit.

Three of the rebates were for units that meet the target level (2.0 EF). The simple average of the rebate amounts in the three programs for water heaters having 2.0 EF was $141. This amount represents about 15 percent of the incremental installed cost of $916 for the target-level unit versus baseline units. DOE therefore assumed that a rebate program for electric storage large rated volume water heaters would offer a rebate amounting to 15 percent of the incremental installed cost of the target-level unit versus the baseline unit.

DOE assumed that rebates would remain in effect at the same levels throughout the forecast period (2015–2045).

For gas-fired and electric storage water heaters, DOE first calculated B/C ratios without a rebate using the difference in lifetime operating costs and lifetime operating cost savings between the unit meeting the target level and the baseline unit. It then calculated B/C ratios given a rebate for the unit meeting the target efficiency. Because the rebate reduced the incremental cost, the unit receiving the rebate had a larger B/C ratio. Table 15.3.1 shows the effects of consumer rebates on lifetime operating cost savings, incremental installed costs, and B/C ratios for gas-fired and electric storage water heaters that meet target efficiency levels.

Table 15.3.1 Benefit/Cost Ratios Without and with Rebates for Water Heaters (2009$)

	Gas-Fired Small Rated Volume	Gas-Fired Large Rated Volume	Electric Small Rated Volume	Electric Large Rated Volume
Benefit (Lifetime Operating Cost Savings)	$113	$893	$163	$1696
Increase in Installed Cost	$92	$805	$140	$974
B/C Ratio Without Rebate	1.2	1.1	1.2	1.7
Rebate Amount	$56	$241	$97	$141
Increase in Installed Cost with Rebate	$36	$564	$43	$833
B/C Ratio with Rebate	3.1	1.6	3.8	2.0

DOE used the B/C ratios along with the penetration curves shown in Figures 15.3.1 through 15.3.4 to estimate the percentage of consumers who would purchase water heaters that meet the target levels both with and without a rebate incentive.

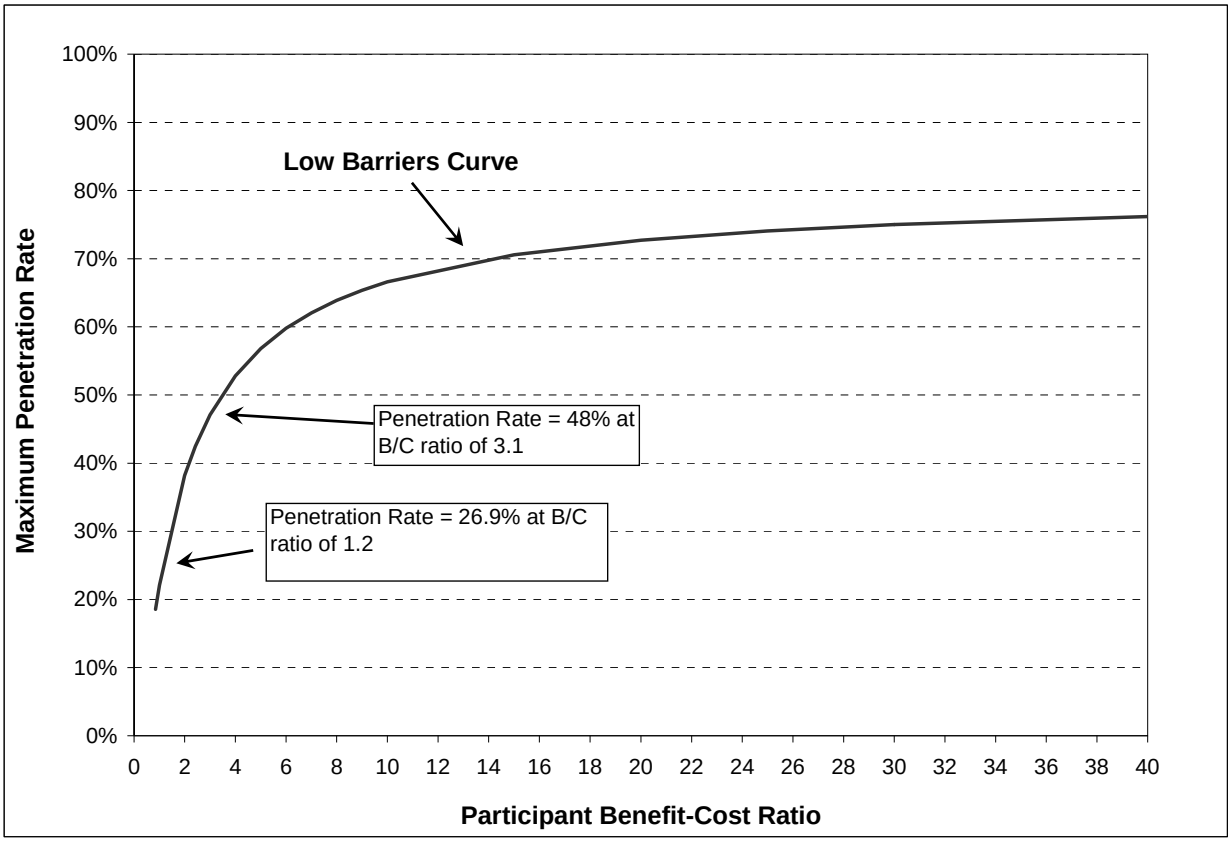

Figure 15.3.1 Market Penetration Curve for Gas-Fired Small Rated Volume Storage Water Heaters

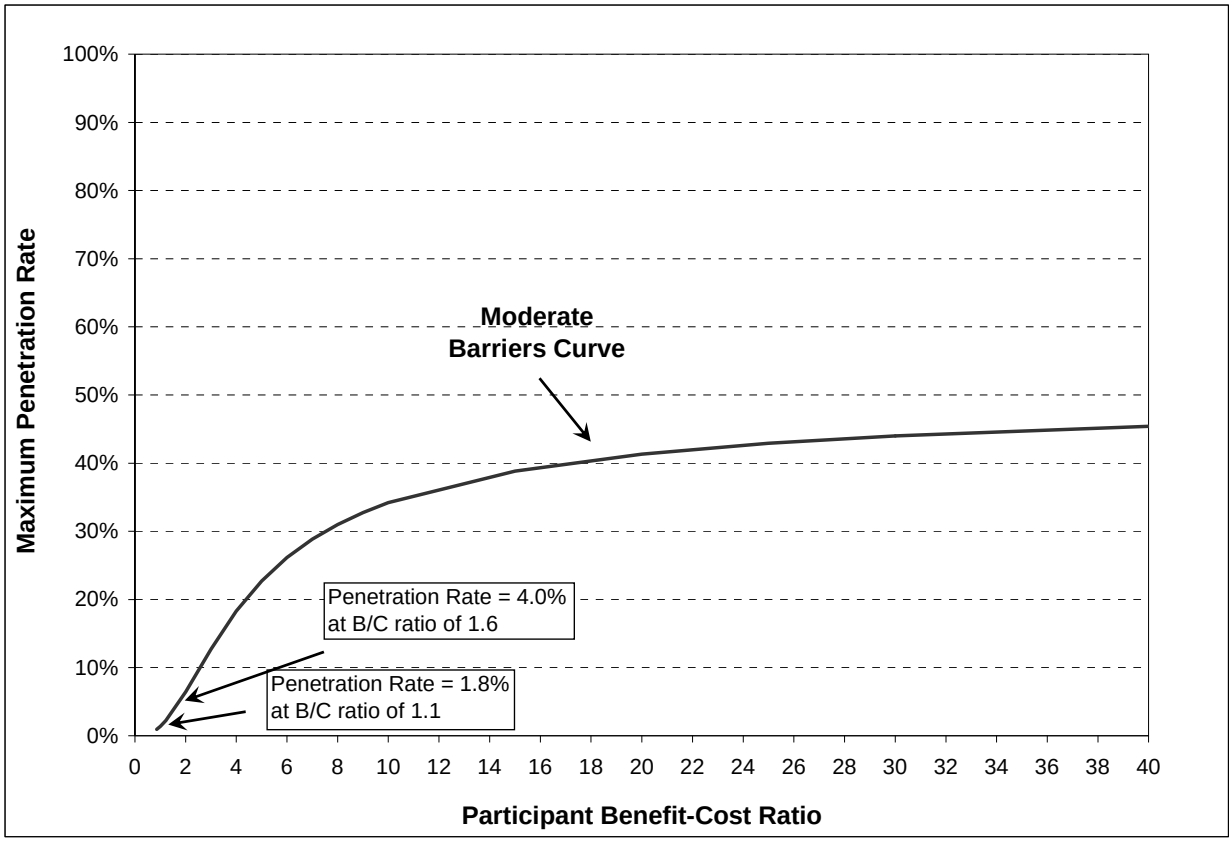

Figure 15.3.2 Market Penetration Curve for Gas-Fired Large Volume Storage Water Heaters

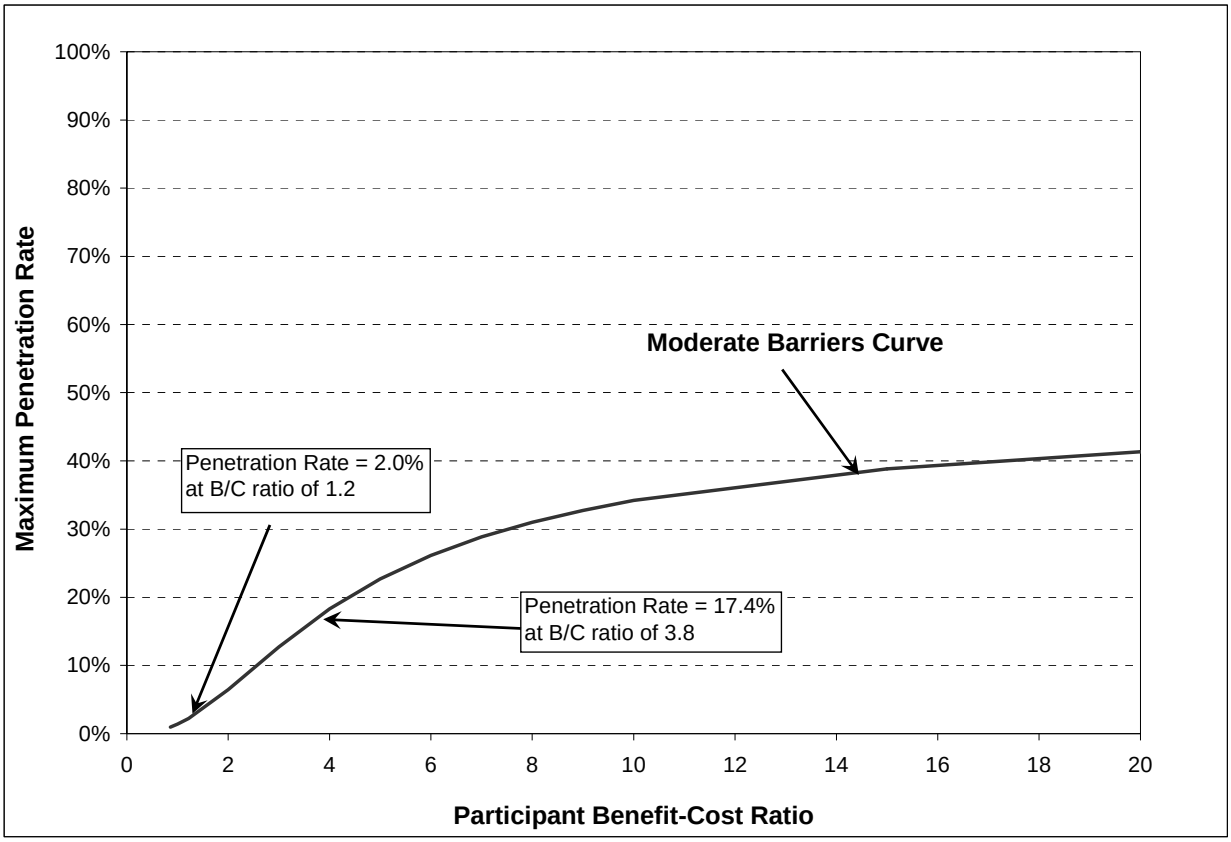

Figure 15.3.3 Market Penetration Curve for Electric Small Volume Storage Water Heaters

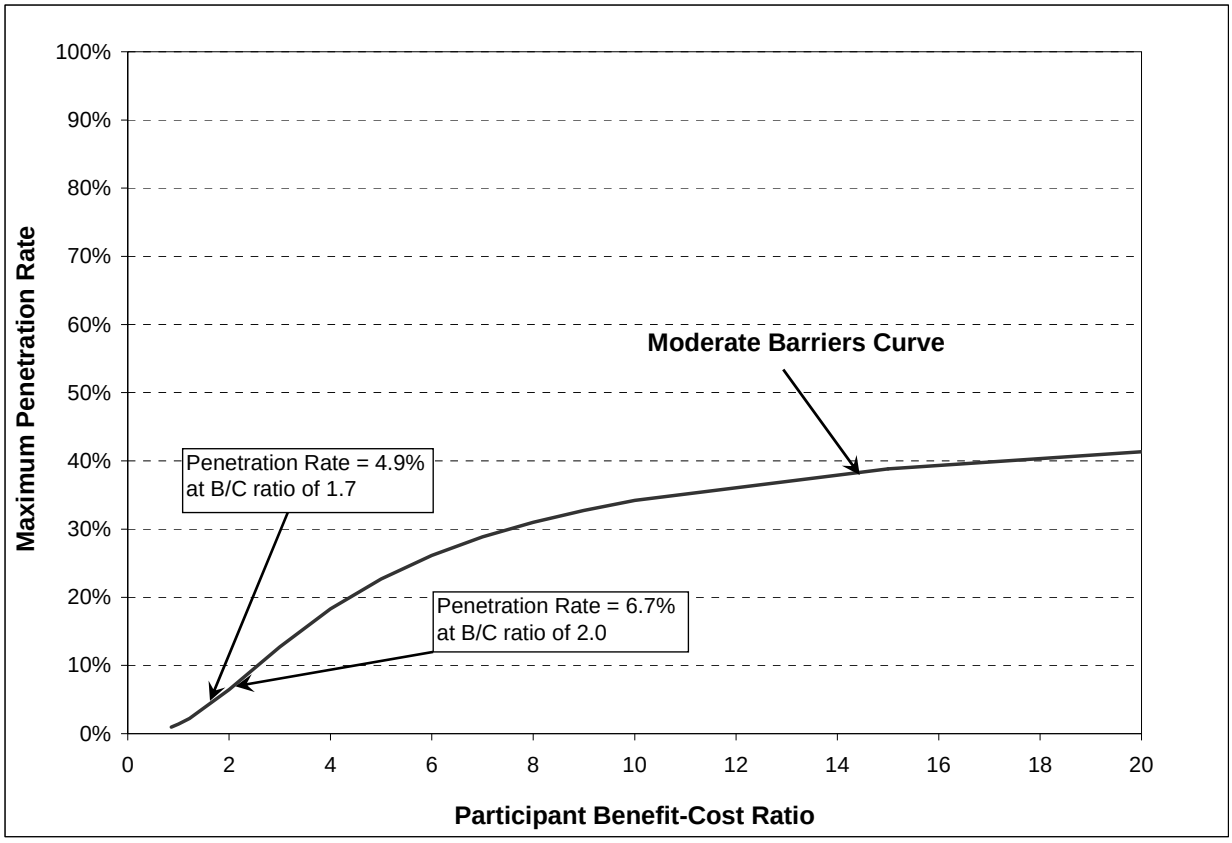

Figure 15.3.4 Market Penetration Curve for Electric Large Rated Volume Storage Water Heaters

DOE selected the *low barriers* penetration curve as most descriptive of the market for gas-fired small rated volume storage water heaters. The product that meets the chosen efficiency level is readily available to consumers, although there are some barriers lf lack of consumer awareness of options and the urgent nature of many water heater replacements. DOE predicted that in 2015 the base-case market share of small rated volume units that meet the target level of 0.62 would be 36 percent, which is closest to the market share of 26.9 percent on the low barriers curve for a unit having a B/C ratio of 1.2.

DOE selected the *moderate barriers* penetration curve for gas-fired large rated volume storage water heaters, assuming the main barrier to be incremental first cost. DOE predicted that in 2015 the base-case market share of large rated volume units that meet the target level of 0.77 would be 1.4 percent, which is closest to the market share of 1.8 percent on the moderate barriers curve for a unit having a B/C ratio of 1.1.

DOE selected the *moderate barriers* penetration curve for both small rated volume and large rated volume electric storage water heaters. Along with the barriers affecting purchase of gas-fired storage water heaters, electric units face an additional barrier because the increased insulation width may limit the location of a new unit. DOE projected that in 2015 the base-case market share of units with small rated volume that meet the target level of 0.95 would be 9.6

percent, which is closest to the market share of 2.0 percent on the moderate barriers curve for a unit having a B/C ratio of 1.2. DOE projected that in 2015 the base-case market share of units with large rated volume that meet the target level of 2.0 is predicted to be 5.2 percent, which is closest to the market share of 4.9 percent on the moderate barriers curve for a unit having a B/C ratio of 1.7.

For each product class, DOE next estimated the relative percent increase represented by the change in penetration rate shown on the penetration curve. It then multiplied the market share of units that meet the target level in the base case by that percent increase to obtain the market share of units that meet the target level in the rebate case. DOE applied a constraint that the market penetration of units in the rebate case would not exceed the highest market share on the selected penetration curve. DOE then calculated the market share penetration increases for GSWH and ESWH by weight-averaging by the percentage of their 2015 shipments projections by rated volume. For GSWH, 96 percent of projected shipments have small rated volume (less than 56 gallons) while 4 percent of shipments have large rated volume (greater than or equal to 56 gallons). For ESWH, 91 percent of projected shipments have small rated volume while 9 percent of shipments have large rated volume.

Table 15.3.2 summarizes market shares of target-level gas-fired and electric storage water heaters estimated for 2015. For gas-fired storage water heaters with small rated volume, DOE estimated that a rebate policy would result in a 50 percent market share of products that meet the target efficiency level. DOE assumed that this market share would be constant throughout the forecast period. (Fifty percent is the maximum achievable market share on the moderate barriers penetration curve). For GSWH with large rated volume, a rebate policy would result in a 3 percent market share of products that meet the target efficiency level; this market share would remain constant throughout the forecast period. For electric storage water heaters with small rated volume, DOE estimated that a rebate policy would result in a 50 percent market share of products that meet the target level, again assuming that this market share would remain constant throughout the forecast period. For ESWH with large rated volume, a rebate policy would result in a 7 percent market share of products that meet the target efficiency level; this market share would remain constant throughout the forecast period.

Table 15.3.2 Market Penetrations in 2015 Without and with Rebates for Water Heaters

	Gas-Fired Storage Small Rated Volume %	Gas-Fired Storage Large Rated Volume %	Gas-Fired Storage Average %	Electric Storage Small Rated Volume %	Electric Storage Large Rated Volume %	Electric Storage Average %
Market Penetration Without Rebate (Moderate Barriers Penetration Curve)	26.9	1.8		2.0	4.9	
Market Penetration with Rebate (Moderate Barriers Penetration Curve)	48.0	4.0		17.4	6.7	
Relative Percent Increase in Market Penetration	79	124		762	36	
Base-Case Market Share of Units that Meet Target Levels	36	1.4	34.6	9.6	5.2	9.4
Market Share of Units that Meet Target Levels Under Rebate	65.3	3.0	61.9	50	7.0	48.3
Increased Market Share of Units that Meet Target Level Under Rebate	28.4	1.7	27.3	40.4	1.9	36.9

To calculate the impacts of the rebate policy, DOE subtracted the market shares of gas-fired and electric storage water heaters that meet target efficiencies in the base case from the estimated market shares that meet target efficiencies in the rebate case for each year. Although DOE assumed that the market shares induced by the rebate policy would be constant, the base-case market shares of gas-fired and electric storage water heaters that meet target levels change annually. Therefore the increased market shares used as inputs to the RIA model also change annually for the policy cases. See Appendix 15-A, Table 15-A.1.1, for the annual increases in market shares for gas-fired and electric storage water heaters meeting target efficiency levels under a rebate policy. DOE used these increases in market shares as inputs to represent the policy case scenarios in its RIA model. Section 15.4 presents the resulting efficiency trends for the policy case of consumer rebates for water heaters.

15.3.2.2 Direct Heating Equipment

For direct heating equipment, DOE estimated the effect of increasing the B/C ratio via a rebate that would pay part or all of the increased installed cost of a unit that meets the target efficiency level compared to the cost of a unit meeting the baseline level. DOE based the rebate amounts on small samples of utility and agency rebate programs for direct heating equipment.

For gas wall fan DHE, DOE gathered data on rebate programs provided by five utilities or agencies in four States. (Appendix 15-A, section 15.3.3, identifies the rebate programs.) The rebates were offered for natural gas or propane space heaters. Most of these rebates did not stipulate an efficiency level and appeared to be incentives for installing new gas space heaters or replacing non-gas heaters with gas units, rather than incentives for purchasing efficient units.

One rebate stipulated an efficiency level higher than the target (standard) level. Given the paucity of identified rebate programs, DOE used the data from all five programs as representative of the rebate amount for this policy case. The simple average of the rebate amounts in the programs, $89, was greater than the increase in installed price of $81 for gas wall fan units that meet the target efficiency level compared to those at baseline levels. DOE therefore assumed that a rebate program for gas wall fan units would provide a rebate amounting to100 percent of the incremental installed cost of the target-level unit compared to the baseline unit.

For gas hearth DHE, DOE gathered data on rebate programs provided by six utilities or agencies in six States. (Appendix 15-A, section 15.3.4, identifies the rebate programs.) The rebates were offered for natural gas or propane gas logs. Most of these rebates did not stipulate an efficiency level and appeared to be incentives for installing new gas hearth DHE, rather than incentives for purchasing efficient units. One rebate stipulated an efficiency level higher than the target (standard) level. Given the paucity of identified rebate programs, DOE used the data from all six programs as representative of the rebate amount for this policy case. The simple average of the rebate amounts in the programs, $70, was 85 percent the increase in installed price of $82 for gas hearth DHE that meet the target efficiency level compared to those at baseline levels. DOE therefore assumed that a rebate program for gas hearth DHE would provide a rebate amounting to 85 percent of the incremental installed cost of the target-level unit compared to the baseline unit.

DOE assumed that rebates would remain in effect until the market had been transformed; that is, the shift in market share of efficient units seen in the first year of the rebate program would be maintained throughout the forecast period (2013–2043).

For direct heating equipment, DOE first calculated B/C ratios without a rebate using the difference in lifetime operating costs and total installed costs between the unit meeting the target level and the baseline unit. It then calculated B/C ratios given a rebate for the unit meeting the target efficiency. Because the rebate reduced the incremental cost, the unit receiving the rebate had a larger B/C ratio. Table 15.3.3 shows the effects of consumer rebates on lifetime operating cost savings, incremental installed costs, and B/C ratios for direct heating equipment that meets target efficiency levels.

Table 15.3.3 Benefit/Cost Ratios Without and with Rebates for Direct Heating Equipment

	Gas Wall Fan	Gas Hearth
Benefit (Lifetime Operating Cost Savings)	$326	$360
Increase in Installed Cost	$81	$92
B/C Ratio Without Rebate	4.0	4.4
Rebate Amount	$89	$70
Increase in Installed Cost with Rebate	$0	$12
B/C Ratio with Rebate	Infinite	29

DOE used the B/C ratios along with the penetration curves shown in Figures 15.3.5 and 15.3.6 to estimate the percentage of consumers who would purchase direct heating equipment units that meet the target efficiency level both with and without a rebate incentive.

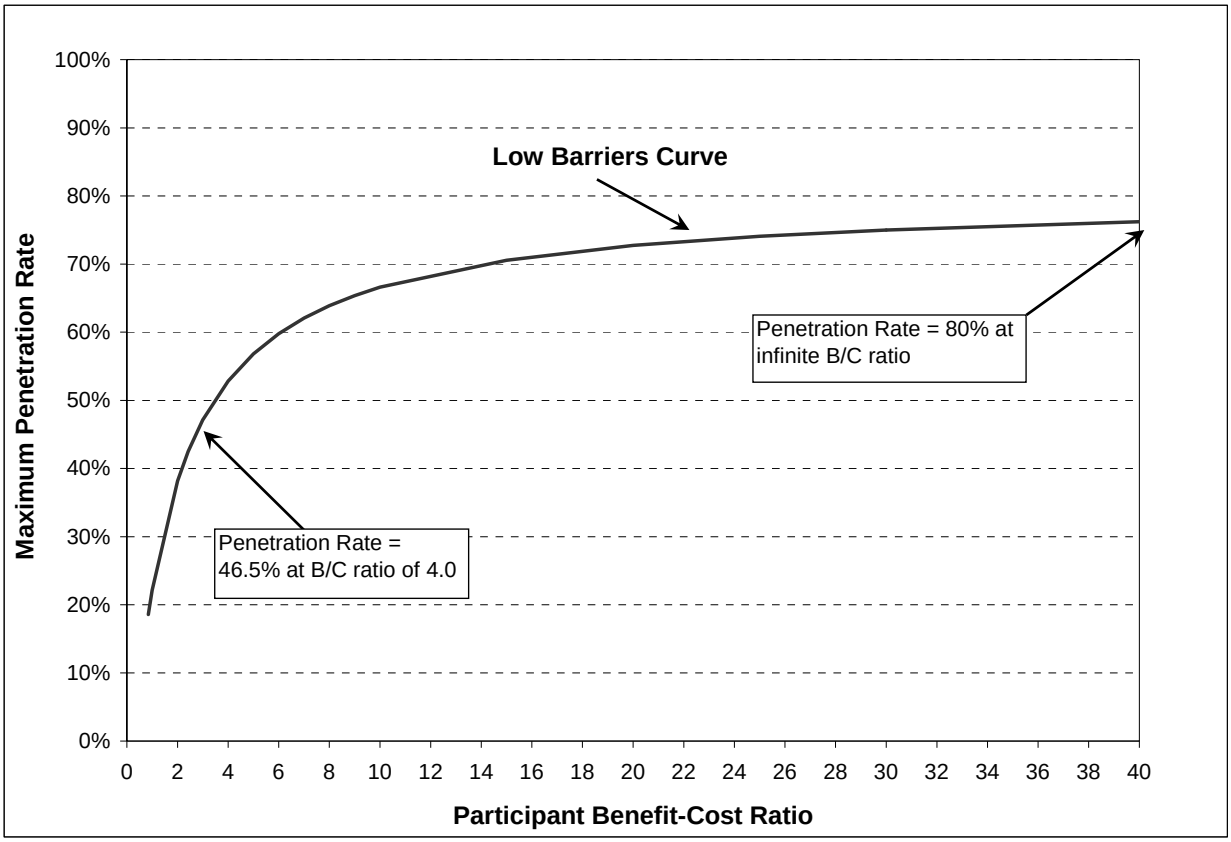

Figure 15.3.5 Market Penetration Curve for Gas Wall Fan DHE

Note that the part of the penetration curve shown in Figure 15.3.5 does not show the 80 percent penetration that would result from the infinite B/C ratio produced when a rebate covers the entire incremental cost of a target-level unit.

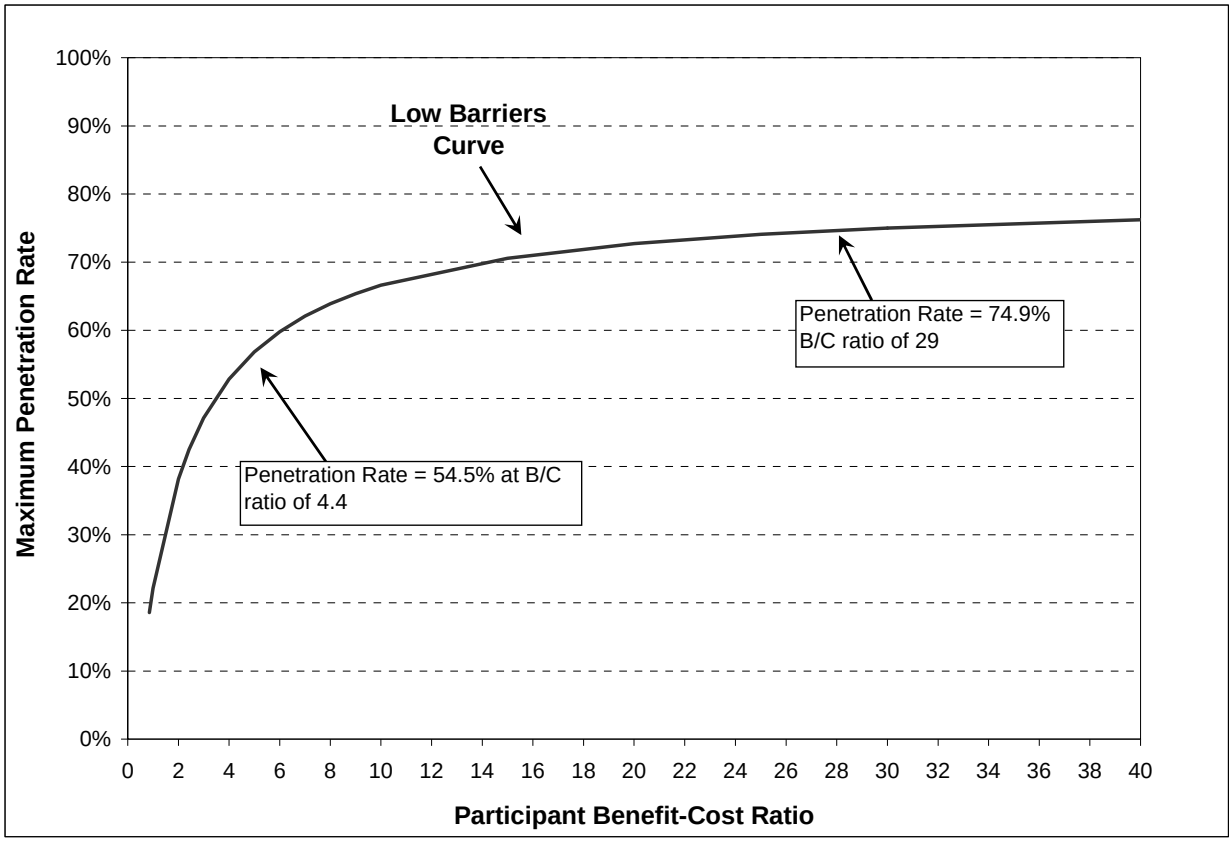

Figure 15.3.6 Market Penetration Curve for Gas Hearth DHE

For gas wall fan DHE, DOE selected the *low barriers* curve, since the consumer utility of the target-level unit (which uses electronic ignition) is similar to that of the baseline unit and the price difference is fairly small relative to total installed cost. In 2013 the base-case market share for units that meet the target level is projected as 53 percent, which is closest to the market share of 53 percent on the moderate barriers curve for a unit having a B/C ratio of 4.0.

For gas hearth DHE, DOE selected the *low barriers* curve because the consumer utility of the target-level unit (which uses electronic ignition) is similar to that of the baseline unit; the price difference is fairly small relative to total installed cost; and efficient units are readily available. In 2013 the base-case market share for units that meet the target level is projected as 60.7 percent, which is closest to the market share of 54.5 percent on the low barriers curve for a unit having a B/C ratio of 4.4.

For each product class, DOE estimated the relative percent increase represented by the change in penetration rate shown on the penetration curves. It then multiplied the market share of units meeting the target level in the base case by that percent increase to obtain the market share of units that meet the target level under a rebate policy. DOE applied a constraint that the market penetration of units in the rebate case would not exceed the highest market share on the penetration curve.

For gas wall fan DHE, DOE estimated that a rebate policy would result in an 80 percent market share of products that meet the target efficiency level. For gas hearth DHE, DOE estimated that a rebate policy would result in an 80 percent market share of products that meet the target efficiency level. For both product classes DOE also assumed that the base-case market shares of products that meet the target efficiency level would remain constant throughout the forecast period. Therefore, DOE also assumed that for both product classes the policy case market shares would be constant throughout the forecast period. (Eighty percent is the maximum achievable market share on the low barriers penetration curve). Table 15.3.4 summarizes market shares of gas wall fan DHE and gas hearth DHE predicted for 2013 for units that meet target efficiency levels.

Table 15.3.4 Market Penetration in 2013 Without and with Rebates for Direct Heating Equipment

	Gas Wall Fan %	Gas Hearth %
Market Penetration Without Rebate (Low Barriers Penetration Curve)	53.0	54.5
Market Penetration with Rebate (Low Barriers Penetration Curve)	80.0	74.9
Relative Percent Increase in Market Penetration	51	118
Base-Case Market Share of Units That Meet Target Level	53.0	60.7
Market Share of Units That Meet Target Level under Rebate Policy	80.0	80.0
Increased Market Share of Units That Meet Target Level under Rebate Policy	27.0	19.3

To calculate the impacts of the rebate policy, DOE subtracted the market shares of direct heating equipment that meet target efficiencies in the base case from the estimated market shares that meet target efficiencies in the rebate case for each year. DOE used the increased market shares attributable to the rebate policy, shown in Table 15.3.4, as inputs to the RIA model. Section 15.4 presents the resulting efficiency trends for the policy case of consumer rebates for direct heating equipment.

15.3.2.3 Pool Heaters

For pool heaters, DOE estimated the effect of increasing the B/C ratio via a rebate that would pay part or all of the increased installed cost of a unit that meets the target efficiency level compared to one meeting the baseline efficiency level. DOE based the rebate amounts on a small sample of utility and agency rebate programs for pool heaters.

For gas-fired pool heaters, DOE gathered data on rebate programs provided by five utilities or agencies in five States. (Appendix 15-A, section 15.3.5, identifies the rebate programs.) The rebates were offered for natural gas-fired pool heaters. None of the rebates

stipulated an efficiency level. The rebates appeared to be incentives for installing new gas-fired pool heaters or replacing non-gas heaters with gas-fired units, rather than incentives for purchasing efficient units. Given the paucity of identified rebate programs, however, DOE used the data from all five programs as representative of the rebate amount for this policy case. The simple average of the rebate amounts in the programs, $199, was greater than the increase in installed price of $103 for pool heaters that meet the target efficiency level compared to those at baseline levels. DOE therefore assumed that a rebate program for pool heaters would provide 100% percent of the incremental installed cost of the target-level unit compared to the baseline unit.

DOE assumed the rebates would remain in effect until the market had been transformed; that is, the shift in market share of efficient units seen in the first year of the program would be maintained throughout the forecast period (2013–2043).

For pool heaters, DOE first calculated B/C ratios without a rebate using the difference in lifetime operating costs and total installed costs between the unit meeting the target level and the baseline unit. DOE then calculated B/C ratios given a rebate for the unit meeting the target level. Because the rebate reduced the incremental cost, the unit receiving the rebate had a larger B/C ratio. Table 15.3.5 shows the effects of consumer rebates on lifetime operating cost savings, incremental installed costs, and B/C ratios for gas-fired pool heaters that meet the target efficiency level.

Table 15.3.5 Benefit/Cost Ratios Without and with Rebates for Pool Heaters

	Gas-Fired Pool Heaters
Benefit (Lifetime Operating Cost Savings)	$226
Increase in Installed Cost	$103
B/C Ratio Without Rebate	2.2
Rebate Amount	$199
Increase in Installed Cost with Rebate	$0
B/C Ratio with Rebate	Infinite

DOE used the B/C ratios along with the penetration curve shown in Figure 15.3.7 to estimate the percentage of consumers who would purchase units that meet the target efficiency level with and without a rebate incentive. Note that the part of the penetration curve shown in Figure 15.3.7 does not show the 80 percent penetration that would result from the infinite B/C ratio produced when the rebate covers the entire incremental cost of the high efficiency unit.

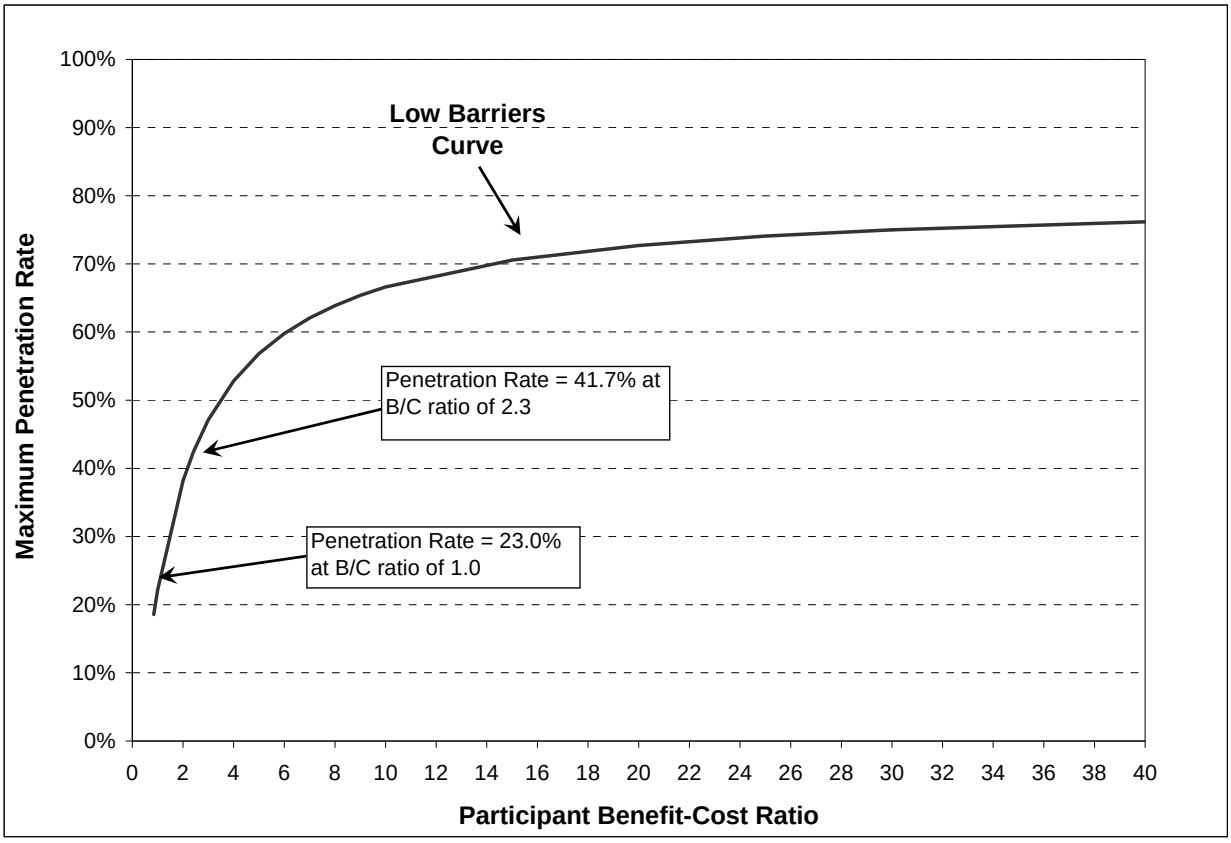

Figure 15.3.7 Market Penetration Curve for Gas-Fired Pool Heaters

For pool heaters, DOE selected the *low barriers* curve because the consumer utility of the unit that meets the target level (via an improved heat exchanger) is similar to that of the baseline unit and efficient units are readily available. In 2013 the base-case market share for units that meet the target level is predicted to be 51.2 percent, which is closest to the market share of 40.2 percent on the low-barriers penetration curve for a unit having a B/C ratio of 2.2.

DOE estimated the relative percent increase represented by the change in penetration rate shown on the penetration curve. It then multiplied the market share of units that meet the target efficiency level in the base case by that percent increase to obtain the market share of units that meet the target level under a rebate policy. DOE applied a constraint that the market penetration of units in the rebate case would not exceed the highest market share on the penetration curve.

Table 15.3.6 summarizes the market shares of target-level pool heaters in 2013. DOE estimated that a rebate policy would result in an 80 percent market share of products that meet the target efficiency level. DOE assumed that this market share would remain constant throughout the forecast period, (eighty percent is the maximum achievable market share on the low barriers penetration curve). DOE also assumed that the base-case market shares of pool heaters that meet the target level remain constant throughout the forecast period.

DOE used the increased market shares attributable to the rebate policy, shown in Table 15.3.6, as inputs to the RIA model. Section 15.4 presents the resulting efficiency trends for the policy case of consumer rebates for gas-fired pool heaters.

Table 15.3.6 Market Penetrations in 2013 Without and with Rebates for Gas-Fired Pool Heaters That Meet Target Efficiency Levels

	Market Share %
Market Penetration Without Rebate (Low Barriers Penetration Curve)	40.2
Market Penetration with Rebate (Low Barriers Penetration Curve)	80.0
Relative Percentage Increase in Market Penetration	99
Base-Case Market Share of Units That Meet Target Level	51.2
Market Share of Units That Meet Target Level under Rebate Policy	80
Increased Market Share of Units That Meet Target Level under Rebate Policy	28.8

15.3.3 Consumer Tax Credits

DOE estimated the effects of tax credits on consumer purchases based on its previous analysis of consumer participation in tax credits. DOE supported its approach using data from Oregon State's tax credit program for energy efficient appliances. DOE also incorporated previous research that disaggregated the effect of rebates and tax credits into a *direct price effect*, which derives from the savings in purchase price, and an *announcement effect*, which is independent of the amount of the incentive.[9, 10] The announcement effect derives from the credibility that a technology receives from being included in an incentive program, as well as changes in product marketing and modifications in markup and pricing. DOE assumed that the rebate and consumer tax credit policies would encompass both direct price effects and announcement effects, and that half the increase in market penetration associated with either policy would be due to the direct price effect and half to the announcement effect.

In estimating the effects of a tax credit on purchases of consumer products that meet new efficiency standards, DOE assumed the amount of the tax credit would be the same as the corresponding rebate. That is, DOE assumed that a tax credit would equal 61 percent of the incremental cost of a gas-fired small rated volume storage water heater that meets the target level, 30 percent of the incremental cost of a gas-fired large rated volume storage water heater, 73 percent of the incremental cost of an electric storage small rated volume water heater, 15 percent of the incremental cost of an electric storage large rated volume water heater, 100 percent of the incremental cost of gas wall fan DHE, 85 percent of the incremental cost of gas hearth DHE, and 100 percent of the incremental cost of gas-fired pool heaters that meet the target level.

DOE estimated that fewer consumers would participate in a tax credit program than would take advantage of a rebate. Research has shown that the delay required for a consumer to receive a tax credit, plus the added time and cost in preparing the tax return, make a tax credit incentive less effective than a rebate received at the time of purchase. Based on previous analyses, DOE assumed that only 60 percent of the consumers who would take advantage of a rebate would take advantage of a tax credit.[11]

DOE also reviewed its analysis of Oregon State tax credits, in particular those for clothes washers.[12] (Additional discussion of Oregon State tax credits is below.) DOE compared the market shares of ultra-high efficiency (UHE) residential clothes washers in Oregon, which offered both State tax credits and utility rebates, with those in Washington State, which offered only rebates during the same period. Based on this analysis, DOE estimated that in Oregon the impact of tax credits was 62 percent of the impact of rebates for UHE clothes washers having the same efficiency. This finding supports the assumption that participation in a tax credit program would be about 60 percent of participation in a rebate program.

DOE also reviewed other tax credit programs that have been offered at both the Federal and State levels for energy efficient appliances. The Energy Policy Act of 2005 (EPACT 2005) included Federal tax credits for consumers who purchase gas, oil, or electric heat pump water heaters for new or existing homes.[13, 14] Those tax credits were in effect in 2006 and 2007, expired in 2008, and were reinstated for 2009–2010 by ARRA.[15] The tax credits for water heaters, however, apply to units much more efficient than stipulated in the chosen standards. Natural gas, propane, or oil water heaters are required to have 0.82 EF or greater to receive a tax credit; electric water heaters must be heat pump water heaters having 2.0 EF or greater. As of this writing, the IRS had not published data on the numbers of taxpayers who claimed the tax credits during tax years 2006, 2007 and 2008. Hence, in this analysis DOE was unable to use data related to the Federal tax credits for water heaters. Appendix 15-A, section 15.4.1, gives details on the products eligible for Federal tax credits for various residential appliances.

The States of Oregon and Montana have offered consumer tax credits for efficient appliances for several years, and the States of Indiana and Kentucky began offering such credits in 2009. The Oregon Department of Energy (ODOE) has separated out data on taxpayer participation in credits for water heaters. (Montana's Department of Revenue does not disaggregate participation data by appliance). The Oregon tax credits, however, are for units having efficiencies higher than the levels stipulated in the chosen standards. The Oregon tax credits apply to advanced technologies such as tankless gas-fired or heat pump electric water heaters, whereas there are conventional gas-fired or electric storage water heaters that can meet the target efficiency levels analyzed in this RIA. Participation in Oregon's tax credits for water heaters has been much lower than for other residential appliances such as clothes washers or dishwashers. ODOE speculates that this difference reflects the fact that water heaters often are replaced at failure, requiring a quick decision and a readily available product. The advanced technologies required to earn a tax credit also are more expensive and more complex to install than are conventional storage water heaters.[16] Hence, DOE did not use ODOE tax credit data on water heaters to predict consumer response to this policy. Appendix 15-A, section 15-A.4.2,

provides details of the products covered and the amounts of State tax credits offered for residential appliances.

DOE identified no State consumer tax credits for direct heating equipment or pool heaters to use in estimating the impacts of consumer tax credits for those products. As mentioned above, however, DOE used its analysis of ODOE data for residential clothes washers as support for its assumption that tax credits induce the participation of about 60 percent as many consumers as do rebates. DOE applied that percentage to consumer tax credits for water heater, direct heating equipment, and pool heater products.

DOE applied the assumed 60 percent participation described above to the penetration rates estimated for the rebate policy to estimate penetration rates attributable to consumer tax credits. In doing so, DOE incorporated the assumptions for consumer response to financial incentives from the XENERGY penetration curves selected for each product class. In response to a tax credit, the 2015 market share of gas-fired storage water heaters that meet target-level efficiency would increase from 17.4 percent (the base-case market share) to an estimated 36.9 percent. For efficient electric storage water heaters, the 2015 market share would increase from 10.1 percent to 34.0 percent. For gas wall fan DHE, the 2013 market share of efficient units would increase from 13.6 percent to 29.6 percent. For gas hearth DHE, the market share of efficient units would increase from 50.9 percent to 65.1 percent. For gas-fired pool heaters, the 2013 market share of efficient units would increase from 21.6 percent to 32.1 percent.

Table 15.3.8 summarizes DOE's assumptions regarding the market penetration of each product given a consumer tax credit in 2015 for water heaters and in 2013 for direct heating equipment and pool heaters that meet target efficiency levels.

Table 15.3.7 Start-Year Market Penetrations Attributable to Consumer Tax Credits for Heating Products

	Gas-Fired Storage Water Heaters %	Electric Storage Water Heaters %	Gas Wall Fan DHE* %	Gas Hearth DHE %	Gas-Fired Pool Heaters %
Base-Case Market Share of Units That Meet Target Level	34.6	9.2	53.0	60.7	51.2
Market Share of Units That Meet Target Level Given Consumer Tax Credits	51.0	31.4	69.2	72.3	68.5
Increased Market Share of Units That Meet Target Level Given Consumer Tax Credits	16.4	22.2	16.2	11.6	17.3

* Direct heating equipment.

DOE assumed that this policy would transform the market permanently, so that the increase in market share seen in the first year of the program for direct heating equipment and

pool heaters would be maintained throughout the forecast period. Because the base-case market share of water heaters that meet target levels changes annually, the increases in market penetration under the policy case also change annually. See Appendix 15-A, Table 15-A.1.2, for the annual increases in market shares for both gas-fired and electric storage water heaters that meet target efficiency levels.

The increased market shares attributable to a consumer tax credit shown in Tables 15.3.8 and 15-A.1.2 were used as inputs to the RIA model. Section 15.4 presents the resulting efficiency trends for the policy case of consumer tax credits for water heaters, direct heating equipment, and gas-fired pool heaters that meet target efficiency levels.

15.3.4 Manufacturer Tax Credits

To analyze the potential effects of a policy that offers tax credits to manufacturers that produce heating products that meet target efficiency levels, DOE assumed that a manufacturer tax credit would lower the consumer's purchase cost by an amount equivalent to that provided by the consumer rebates or tax credits described above. DOE further assumed that manufacturers would pass on some of their reduced costs to consumers, causing a direct price effect. DOE assumed that no announcement effect would occur, because the program would not be visible to consumers. Because the direct price effect is approximately equivalent to the announcement effect,[9] DOE estimated that a manufacturer tax credit would induce half the number of consumers assumed to take advantage of a consumer tax credit to purchase more efficient products. This assumed participation rate is equal to 30 percent of the number of consumers who would participate in a rebate program.

DOE also attempted to investigate manufacturer responses to the Energy Efficient Appliance Credits for manufacturers mandated by EPACT 2005.[14] Those manufacturer tax credits were in effect in 2006 and 2007 (and reinstated for 2009 and 2010). DOE was unable to locate data from the Internal Revenue Service or other sources on manufacturer response to the Federal credits. Appendix 15-A presents details on Federal manufacturer tax credits.

DOE applied the assumption of 30 percent participation to the penetration rates predicted for the rebate policy to estimate the effects of a manufacturer tax credit policy. In doing so, the Department incorporated the assumptions for consumer response to financial incentives from the XENERGY penetration curves selected for each product class. A manufacturer tax credit was estimated to increase the 2015 market share of target-level gas-fired storage water heaters from the base-case level of 17.4 percent to 27.1 percent. For electric storage water heaters, the 2015 market share of target-level units would increase from 10.1 percent to 22.0 percent. A manufacturer tax credit would increase the 2013 market share of efficient gas wall fan DHE from 13.6 percent to 21.6 percent and the market share of gas hearth DHE from 50.9 percent to 58.0 percent. The 2013 market share of efficient gas-fired pool heaters would increase from 21.6 percent to 26.8 percent.

Table 15.3.10 summarizes DOE's assumptions regarding the market penetration of each product in 2015 for water heaters and in 2013 for direct heating equipment and pool heaters that meet target efficiency levels given a manufacturer tax credit.

Table 15.3.8 Start-Year Market Penetrations Attributable to Manufacturer Tax Credits for Heating Products

	Gas-Fired Storage Water Heaters %	Electric Storage Water Heaters %	Gas Wall Fan DHE %	Gas Hearth DHE %	Gas-Fired Pool Heaters %
Base-Case Market Share of Units That Meet Target Level	34.6	9.2	53.0	60.7	51.2
Market Share of Units That Meet Target Level Given a Manufacturer Tax Credit	42.8	20.3	61.1	66.5	59.9
Increased Market Share of Units That Meet Target Level Given a Manufacturer Tax Credit	8.2	11.1	8.1	5.8	8.6

DOE assumed that this policy would transform the market permanently, so that the increase in market share seen in the first year of the program for direct heating equipment and pool heaters would be maintained throughout the forecast period. Because the base-case market share of water heaters that meet target levels changes annually, their increases in market penetration under the policy case would also change annually. See Appendix 15-A, Table 15-A.1.3, for the annual increases in market shares for both gas-fired and electric storage water heater that meet target efficiency levels.

The increased market shares attributable to a manufacturer tax credit, shown in Tables 15.3.10 and 15-A.1.3 were used as inputs to the RIA model. Section 15.4 presents the resulting efficiency trends for the policy case of manufacturer tax credits for water heaters, direct heating equipment, and gas-fired pool heaters.

15.3.5 Voluntary Energy Efficiency Targets

For each product, DOE assumed that voluntary energy efficiency targets would be achieved as manufacturers gradually stopped producing units that operated below their target levels. DOE assumed that the impetus for phasing out production of low-efficiency units would be a program similar to the ENERGY STAR labeling program conducted by the Environmental Protection Agency (EPA) and DOE. The ENERGY STAR program specifies the minimum energy efficiencies that various products, including residential water heaters, must have to receive the ENERGY STAR label. ENERGY STAR encourages consumers to purchase efficient products via marketing that promotes consumer label recognition, various incentive programs that adopt the ENERGY STAR specifications, and manufacturers' promotion of their qualifying appliances. ENERGY STAR projects market penetration of compliant appliances and estimates the percentage of sales of compliant appliances that are attributable to the ENERGY STAR program.

Researchers have analyzed the ENERGY STAR program's effects on sales of several consumer products. Program efforts generally involve a combination of information dissemination and utility or agency rebates. The analyses have been based on State-specific data on percentages of shipments of various appliances that meet ENERGY STAR specifications. The analyses generally have concluded that the market penetration of ENERGY STAR-qualifying appliances is higher in regions or States where ancillary promotional programs have been active.[17, 18, 19]

15.3.5.1 Water Heaters

To model the effects of a voluntary energy efficiency policy for water heaters, DOE assumed an expansion of current ENERGY STAR efforts for this product. Because the ENERGY STAR program for gas-fired storage water heaters began only in 2008, historical and long-term forecast data on the program's effects were not available as of this writing.[f] DOE therefore developed assumptions regarding market penetration of ENERGY STAR-compliant gas-fired storage water heaters based on EPA experience with a product for which historical and forecast data were available. For gas-fired small rated volume storage water heaters, whose target level in the chosen standard is 0.62 EF, DOE chose to evaluate gas boilers as an analogous product. The efficiency difference between the ENERGY STAR-compliant units and units meeting current Federal efficiency standards when the ENERGY STAR gas boiler specification was created was relatively small, as is the case for the ENERGY STAR specifications for gas-fired storage water heaters in the first years of its program. The ENERGY STAR program has developed projections for 1996–2025 of increased market penetration attributable to its program for efficient gas boilers.[20] DOE estimated that an expanded ENERGY STAR program (as applied to gas-fired small rated volume storage water heaters) would increase the annual market share of efficient units by 50 percent more than the increase attributable to the current ENERGY STAR program for gas boilers beginning in 2002. DOE chose that year because the program had been in effect for 7 years and there was an increase in the specified efficiency that year, similar to the likely situation of gas-fired water heaters in 2015 prior to an expansion of the program under this policy case. DOE calculated the annual relative percent increases in market share for gas boilers represented by the additional 50 percent market share increases described above that would result from an enhanced program. DOE multiplied the market shares of gas-fired storage water heaters that meet the target level in the RIA base case, starting in 2015, by those relative percent increases to obtain the annual market shares of units meeting the target efficiency level in the voluntary targets policy case. (From 2039–2044 DOE used the value for 2038, which corresponded to 2025, the last year of the ENERGY STAR forecast.) DOE assumed that the programs resulting from the expanded voluntary targets policy would produce the projected increases in market share shown in Table 15.3.12.

For gas-fired large rated volume storage water heaters, whose target level in the chosen standard is 0.77 EF, DOE chose to evaluate gas furnaces as an analogous product. The efficiency

[f] The base case for the NIA for gas-fired storage water heaters assumes that the ENERGY STAR program causes the market share of gas condensing water heaters to increase each year of the forecast period. This assumption is reflected in the RIA analysis of the voluntary energy efficiency policy.

difference between the ENERGY STAR-compliant units and units meeting current Federal efficiency standards is relatively large, as both gas furnaces and gas storage water heaters with 0.77 EF use condensing technology. The ENERGY STAR program has developed projections for 1995–2025 of increased market penetration attributable to its program for efficient gas furnaces.[20] DOE estimated that an expanded ENERGY STAR program (as applied to gas-fired large rated volume storage water heaters) would increase the annual market share of efficient units by 50 percent more than the increase attributable to the current ENERGY STAR program for gas furnaces beginning in 1995, the year the program began. DOE calculated the annual relative percent increases in market share for gas furnaces represented by the additional 50 percent market share increases described above that would result from an enhanced program. DOE multiplied the market shares of gas-fired storage water heaters that meet the target level in the RIA base case, starting in 2015, by those relative percent increases to obtain the annual market shares of units meeting the target efficiency level in the voluntary targets policy case. DOE assumed that the programs resulting from the expanded voluntary targets policy would produce the projected increases in market share shown in Table 15.3.12.

Although the ENERGY STAR program does not include efficiency criteria for electric storage water heaters, to analyze this policy case DOE assumed that ENERGY STAR would extend its scope to those products. [g] DOE based its estimates of market penetration of efficient electric small rated volume storage water heaters, whose efficiency level is 0.95, on the ENERGY STAR projections of increased market penetration attributable to the program for efficient gas boilers.[20] DOE estimated that beginning in 2015, a new ENERGY STAR program for electric small rated volume storage water heaters would produce the same annual increases in market share as demonstrated by the current program for gas boilers beginning in 1996. DOE chose 1996, the year the program began, to match the conditions of initial low market share for a new program and used the ENERGY STAR projections from 1996 through 2025 to estimate the impacts of a new program for electric small rated volume storage water heaters. From the ENERGY STAR forecast for gas boilers in those years, DOE calculated the annual relative percent increases in market share for gas boilers represented by the shipments attributed to ENERGY STAR. DOE multiplied the market shares of electric storage water heaters that meet the target level in the RIA base case, starting in 2015, by those percent increases to obtain the annual market shares of units meeting the target efficiency level in the voluntary targets policy case.

The ENERGY STAR program has had a specification for heat pump electric storage water heaters since 2008, so historical data long-term forecast data were not available for this product. For electric storage large rated volume water heaters, whose 2.0 EF represents heat pump technology, DOE based its estimates of market penetration on the ENERGY STAR projections of increased market penetration attributable to the program for efficient residential clothes washers (RCW).[20] The ENERGY STAR specification for both of these products has an efficiency level considerably higher than that of the baseline appliance. DOE estimated that

[g] The base case for the NIA for electric storage water heaters assumes that the ENERGY STAR program causes the market share of heat pump water heaters, for which there is an ENERGY STAR specification, to increase each year of the forecast period. This assumption is reflected in the RIA analysis of the voluntary energy efficiency policy.

beginning in 2015, a new ENERGY STAR program for electric large rated volume storage water heaters would produce 50 percent of the annual increases in market share as demonstrated by the current program for RCW beginning in 1996. DOE chose 1996, the year the program began, to match the conditions of initial low market share for a new program and used the ENERGY STAR projections from 1996 through 2025 to estimate the impacts of a new program for electric large rated volume storage water heaters. From the ENERGY STAR forecast for RCW in those years, DOE calculated the annual relative percent increases in market share for RCW represented by the shipments attributed to ENERGY STAR. DOE multiplied the market shares of electric large rated volume storage water heaters that meet the target level in the RIA base case, starting in 2015, by those percent increases to obtain the annual market shares of units meeting the target efficiency level in the voluntary targets policy case.

DOE estimated that the programs developed in support of the voluntary targets policy would increase market shares of efficient units by the percentages shown in Appendix 15-A, Table 15-A.1.4. Section 15.4 presents the resulting efficiency trends for the policy case of voluntary energy efficiency targets for water heaters that meet target efficiency levels.

15.3.5.2 Direct Heating Equipment

Because there is no ENERGY STAR program for direct heating equipment, DOE based its assumptions regarding increased market penetration on EPA's experience with air source heat pumps. DOE chose air source heat pumps (ASHP) because the initial market share of ENERGY STAR-qualified units was already substantial at the beginning of the program, as it was for gas wall fan DHE and gas hearth DHE. DOE therefore based its estimates of market penetration for these direct heating equipment product classes on the ENERGY STAR projections for 1996–2025 of market penetration attributable to its program for ASHP.[20] DOE estimated that an ENERGY STAR program for gas wall fan DHE and for gas hearth DHE would produce the same patterns of annual increases in market penetration beginning in 2013. From the ENERGY STAR forecast for ASHP, DOE calculated the annual relative percent increases in market share for ASHP units represented by the shipments attributed to ENERGY STAR. DOE multiplied the market shares of gas wall fan DHE and gas hearth DHE that met the target levels in their RIA base cases, starting in 2013, by those percent increases to obtain the annual market shares of units meeting the target efficiency level in the voluntary policy case. Table 15-A.1.4 in Appendix 15-A shows the annual projected increases in market shares of direct heating equipment that would result from a voluntary energy efficiency policy. Section 15.4 presents the resulting efficiency trends for the policy case of voluntary energy efficiency targets for direct heating equipment.

15.3.5.3 Pool Heaters

Because there is no ENERGY STAR program for pool heaters, DOE based its assumptions about market penetration of efficient units on EPA experience with air source heat pumps. DOE chose air source heat pumps (ASHP) because the initial market share of ENERGY STAR-qualified units was already substantial at the beginning of the program, as it was for gas-fired pool heaters. DOE therefore based its estimates of market penetration for pool heaters on

ENERGY STAR projections for 1996–2025 of market penetration attributable to its program for ASHP.[20] DOE estimated that the ENERGY STAR program for pool heaters would produce the same pattern of annual increases in market penetration beginning in 2013. From the ENERGY STAR forecast for ASHP, DOE calculated the annual relative percent increases in market share for ASHP units represented by the shipments attributed to ENERGY STAR. DOE multiplied the market shares of gas-fired pool leaders that met the target levels in the RIA base case, starting in 2013, by those percent increases to obtain the annual market shares of units meeting the target efficiency level in the voluntary policy case. Table 15-A.1.4 in Appendix 15-A shows the annual projected increases in market share of efficient units resulting from a voluntary energy efficiency policy. Section 15.4 presents the resulting efficiency trends for the policy case of voluntary energy efficiency targets for gas-fired pool heaters.

15.3.6 Early Replacement

The non-regulatory policy of early replacement refers to a program to replace residential appliances before the ends of their useful lives. The purpose of such a policy is to replace old, inefficient units with higher efficiency units. The economic feasibility of early replacement depends on the vintage of the unit being replaced, the installed cost of the new unit, and the energy cost savings.

Although the United States has limited experience with early replacement programs for appliances, DOE examined several resources to inform its analysis of the policy. One report detailed the Connecticut Appliance Retirement Program (ARP), which was conducted in 2004.[21] Another was a study of the potentials for electric energy efficiency performed in 2006 for the State of Vermont.[22] DOE also had performed an earlier study on the effectiveness of Federal programs supporting early retirement of appliances under the Energy Policy Act of 1992 (EPACT 1992).

The Connecticut ARP was conducted from June through December 2004 by Nexus Market Research, Inc., and RLW Analytics, Inc., for Northeast Utilities–Connecticut Light and Power and the United Illuminating Company's State programs. The purpose of the ARP was to help Connecticut utility customers overcome barriers to recycling room air conditioners (RACs), secondary refrigerators, and freezers. The program picked up used appliances at customers' homes or at turn-in events, paid participants to retire their units, and educated customers about the costs of operating older appliances. In addition, the program provided consumers with financial incentives to replace inefficient RACs with ENERGY STAR-qualified units. DOE considered the RAC program to most closely resemble the early replacement policy scenario for the three heating products considered herein, because consumers replaced primary units rather than retiring second units. Nexus/RLW used program data and surveys to estimate the number of RACs retired by ARP participants, the percentage of retired units that were replaced with an ENERGY STAR model, and the number of RACs replaced by non-participants during the program. According to the Nexus/RLW analysis, about 7 percent of all RACs retired during the program were retired through the ARP, and 63 percent of those were replaced with ENERGY STAR models. Thus the program resulted directly in about 4 percent of total eligible RAC consumers deciding on early replacement of inefficient units.

In 2006, GDS Associates, Inc., conducted a study for the State of Vermont of the potentials for reducing electricity use and peak demand through energy efficiency and fuel conversion measures. The study took an aggressive, multi-program approach, one aspect of which was early replacement of appliances. GDS considered that under the program residential appliances, including RACs, would be replaced during 4 years (2006–2009). GDS estimated achievable market penetrations assuming that consumers would receive a financial incentive equal to 50 percent of the incremental cost of each measure. GDS assumed an 80 percent penetration limit. For early replacement of RACs, GDS estimated a maximum achievable participation of 5 percent of eligible single-family or multi-family homes in the year before the program began (2005).

DOE also reviewed a study it conducted in the 1990s, under EPACT 1992, which analyzed the feasibility of a Federal program to promote early replacement of appliances.[23] The study identified policy options for early replacement that included a direct national program; replacement of Federally-owned appliances; and promotion through equipment manufacturers, consumer incentives, incentives to utilities, and building regulations.[h]

For this RIA analysis, DOE analyzed a program that would target installed units having efficiency levels that are lower than target levels and encourage their early replacement with products that perform at target levels. For each product, DOE modeled the effects of the early replacement policy by increasing by 4 percent per year the retirement rate of units that were in the stock in the first year of the analysis period (2015 for water heaters and 2013 for direct heating equipment and pool heaters). DOE used the 4 percent rate from the Connecticut study, because it was based on real-world experience. DOE assumed that the early replacement program would continue until it had facilitated the replacement of all eligible residential water heaters, direct heating equipment, and pool heaters in the stock in the year the program began (2015 or 2013). Shipments of new units in 2015/2013 and beyond were not affected by the program, but remained at base-case efficiency levels. After the stock of inefficient units was completely replaced, the policy would produce no additional impacts.

An early replacement policy would create a fairly immediate jump in shipments of products that meet target efficiency levels relative to the base case, as shown in Figures 15.3.6 through 15.3.10. High-efficiency units would be brought quickly into the stock, leading to an immediate gain in the market share of efficient units compared to the base case. As opposed to the policy cases discussed previously, however, an early replacement policy results in market shares of efficient units returning to base-case percentages as the eligible market is depleted. In addition, as the figures illustrate, because units removed early from the stock would have been replaced later (at the ends of their useful lives) without the program, the number of shipments in

[h] The analysis concluded that, although cost-effective opportunities for early replacement exist, a widespread Federal program was not justified economically. Because early retirement means that a unit may be replaced by an appliance less efficient than the eventual replacement would have been, energy savings would be less than anticipated. Early replacement programs also could increase long-term sales volatility by encouraging a temporary increase in production, followed by a lull in demand. Early replacement could be economical in localities subject to high energy costs or environmental constraints; when replacement appliances are much more efficient than existing stock; or when a major technology breakthrough has occurred, creating the need for a ready market.

later years drops below the base-case shipments forecast. The shipments shown in Figures 15.3.6 through 15.3.10 represent units that replace existing units (replacement shipments). Section 15.4 presents the resulting efficiency trends for the policy case of early replacement for water heaters, direct heating equipment, and gas-fired pool heaters.

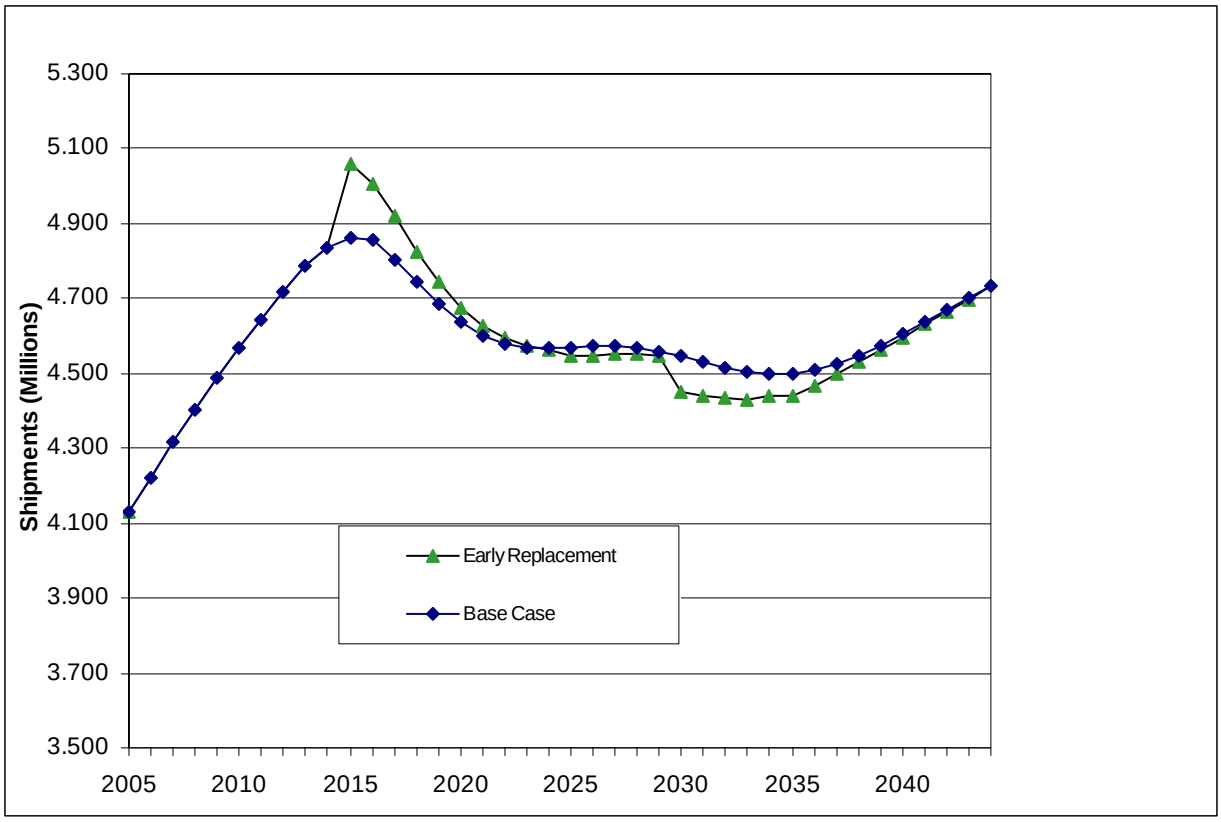

Figure 15.3.8 Estimated Replacement Shipments of Gas-Fired Storage Water Heaters With and Without an Early Replacement Program

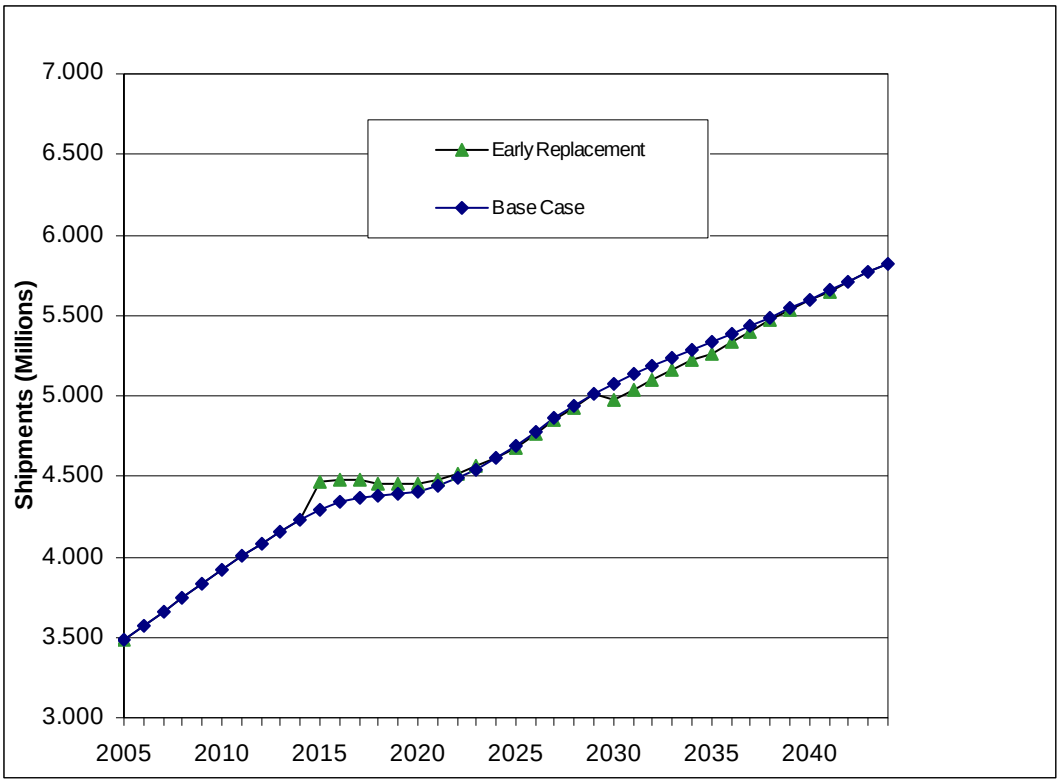

Figure 15.3.9 Estimated Replacement Shipments of Electric Storage Water Heaters With and Without an Early Replacement Program

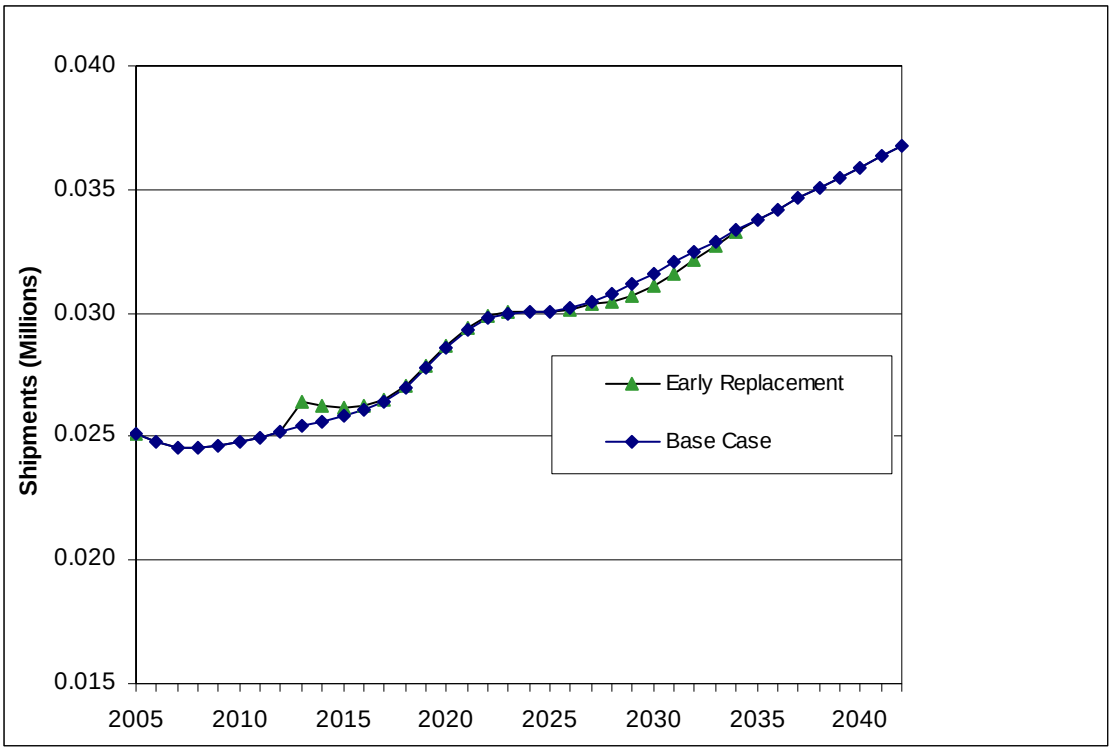

Figure 15.3.10 Estimated Replacement Shipments of Gas Wall Fan DHE With and Without an Early Replacement Program

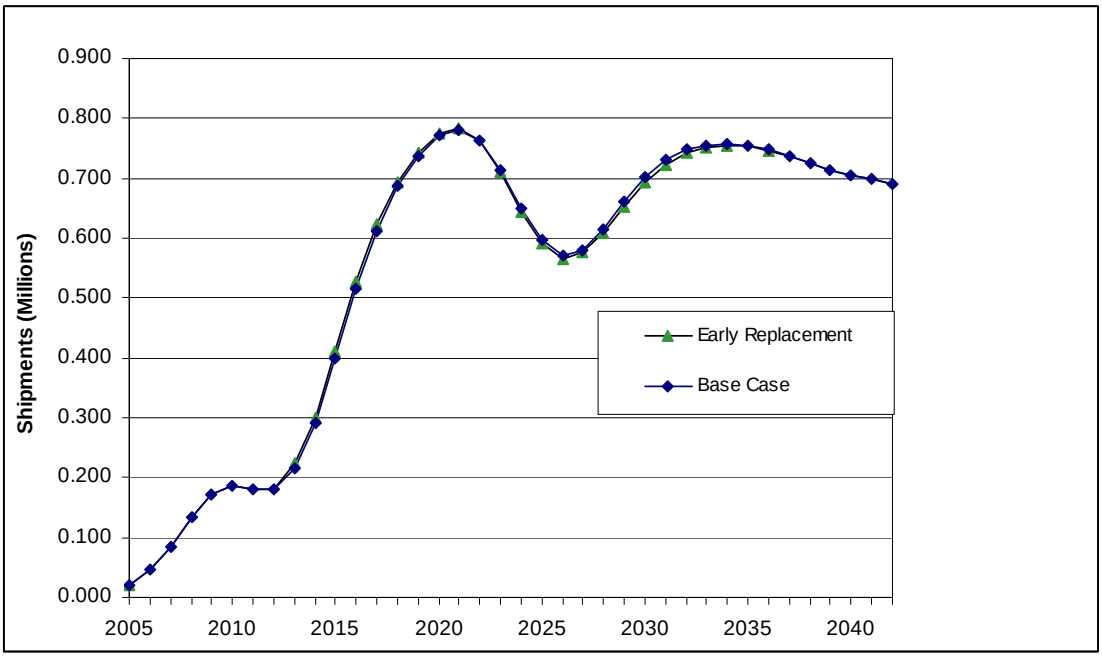

Figure 15.3.11 Estimated Replacement Shipments of Gas Hearth DHE With and Without an Early Replacement Program

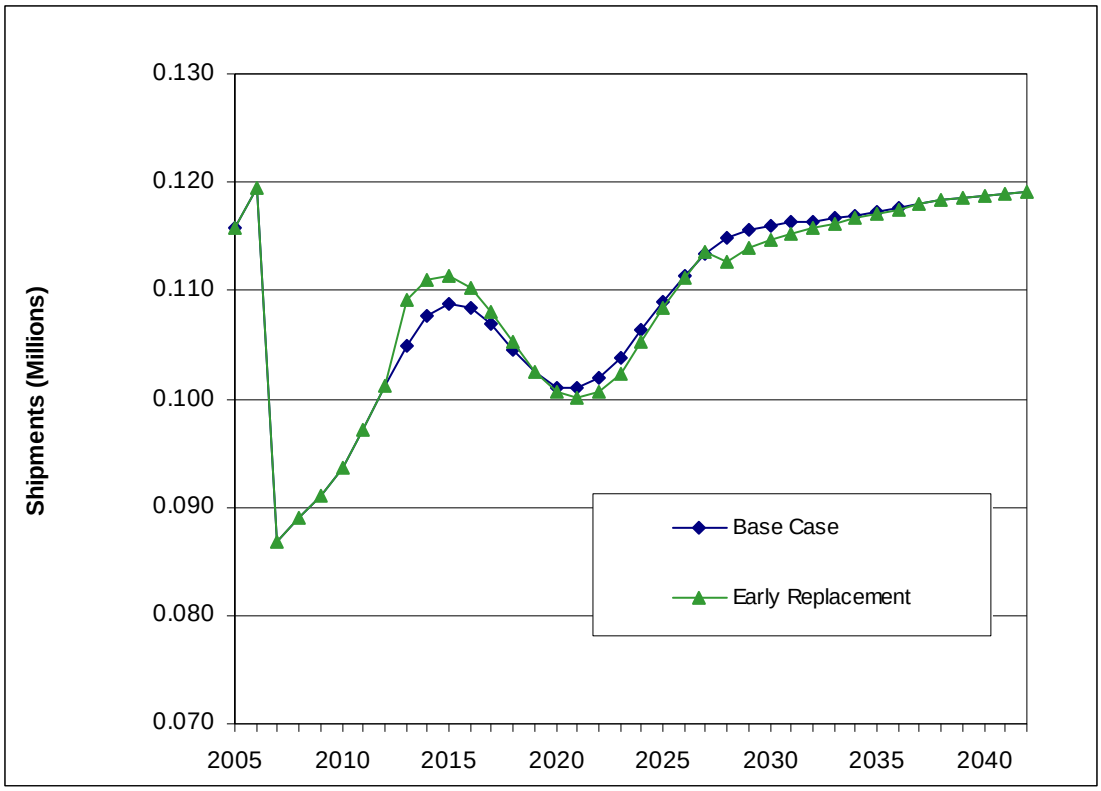

Figure 15.3.12 Estimated Replacement Shipments of Gas-Fired Pool Heaters With and Without an Early Replacement Program

15.3.7 Bulk Government Purchases

DOE assumed that a policy requiring bulk government purchases would lead to Federal, State, and local governments purchasing products that meet target efficiency levels. Combining the demands of multiple public sectors also would provide a market signal to manufacturers and vendors that some of their largest customers seek products that meet an efficiency target at favorable prices. Such a program also could induce "market pull," whereby manufacturers and vendors would achieve economies of scale for high-efficiency products.

Most of the previous bulk government purchase (procurement) initiatives at the Federal, State, and municipal levels have not tracked data on number of purchases or degree of compliance with procurement specifications. In many cases, procurement programs are decentralized, being part of larger State or regional initiatives. DOE based its assumptions regarding the effects of a policy calling for bulk government purchases on studies the Federal Energy Management Program (FEMP) performed regarding the savings potential of its procurement specifications for appliances and other equipment. FEMP, however, does not track purchasing data, because of the range of complex the purchasing systems, number of vendors, etc. States, counties, and municipalities have demonstrated increasing interest and activity in "green purchasing." Although many of the programs target office equipment, the growing infrastructure for developing and applying efficient purchasing specifications indicates that bulk government purchase programs are feasible.[24, 25]

15.3.7.1 Water Heaters

DOE assumed that government agencies, such as the Department of Housing and Urban Development, would administer a bulk purchasing program for gas-fired and electric storage water heaters. The bulk purchasing policy also could be incorporated at the Federal level into the FEMP program, which has established procurement guidelines. Federal construction requirements include the FEMP guidelines for installing or replacing equipment. The current FEMP procurement guidelines for gas-fired storage water heaters of 50 gallons or less are a minimum energy factor (EF) of 0.62 and maximum energy use of 242 therms per year.[26] Current guidelines for electric storage water heaters of less than 60 gallons are a minimum EF of 0.93 and maximum energy use of 4,721 kilowatt-hours (kWh) per year. For electric storage water heaters of 60 gallons or more, the minimum EF is 0.91 and maximum annual energy use is 4,825 kWh per year.[27]

DOE also reviewed its own previous research on the potential for market transformation through bulk government purchases. Its major study analyzed several scenarios based on the assumption that 20 percent of Federal equipment purchases in the year 2000 already incorporated energy efficiency requirements based on FEMP guidelines. One scenario in the DOE report showed energy efficient Federal purchasing ramping up during 10 years from 20 percent to 80 percent of all Federal purchases.[28]

DOE estimated that government-owned residential buildings would have the same percentages of gas-fired and electric storage water heaters that meet target efficiency levels as those of the general population in the base case. DOE estimated that a bulk government purchase program instituted within a 10-year period eventually would result in 80 percent of government-purchased water heaters meeting target efficiency levels.

DOE assumed that bulk government purchases would affect a subset of housing units for which government agencies purchase or influence the purchase of water heaters. This subset would consist primarily of public housing and housing on military bases. DOE defined this subset based on publicly owned housing identified in the American Housing Survey (AHS) for 2005, which was 2.0 million households, or about 1.6 percent of all U.S. households.[29] (the The AHS reports 124.4 million U.S. households.[30]) According to the 2005 Residential Energy Consumption Survey (RECS 2005), 34.5 percent of publicly owned households used gas-fired water heaters and 17 percent used electric water heaters.[31] DOE assumed that the same percentages of publicly owned housing units would operate gas-fired or electric storage water heaters during the forecast period. DOE therefore estimated that 0.6 percent of U.S. housing units represent publicly owned households using gas-fired storage water heaters, and 0.3 percent of units are publicly owned households using electric storage water heaters, which together constitute the populations to which this policy would apply.

Based on the above percentages, DOE estimated that, by the end of the first year of the bulk government purchase policy (2015), an additional 6.3 percent of shipments of government-purchased gas-fired storage and 7.0 percent of electric storage water heaters beyond the base cases for those products would meet target efficiency levels. DOE estimated that by 2024 bulk

government purchasing programs would result in 80 percent of the water heater market for publicly owned housing meeting target levels. DOE modeled the bulk government purchase program assuming that the market share for each product achieved in 2024 would be maintained throughout the rest of the forecast period. Section 15.4 presents the resulting efficiency trends for the policy case of bulk government purchase of water heaters. Appendix 15.A, Table 15-A.5, shows the projected market shares due to the bulk government purchases policy.

15.3.7.2 Direct Heating Equipment

DOE did not analyze the potential effects of bulk government purchases of direct heating equipment, because the market share of those products in publicly owned housing is small. According to RECS 2005, only 2.5 percent of publicly owned housing units use direct heating equipment.

15.3.7.3 Pool Heaters

DOE did not analyze the potential impacts of bulk government purchases of pool heaters, because those products are not used in publicly owned housing. RECS 2005 does not report any pool heaters in use in publicly owned housing units.

15.3.8 State Building Codes—Water Heaters

DOE evaluated the potential impacts of a policy scenario that would allow States through their building codes to require that electric storage water heaters installed in new homes would have an efficiency level higher than the chosen Federal standard. At present, States are prohibited to require efficiency levels higher than the Federal standard; this policy scenario would remove this prohibition in the case of residential electric storage water heaters. In addition, in this scenario, the chosen standards for electric storage water heaters would be in effect, so that electric storage water heaters destined for existing homes would have to meet the chosen standard level. Therefore, the energy savings for this scenario with the State building code requirement for new homes would be greater than the savings from the chosen standard for this product. This contrasts with the RIA policies discussed above, whose savings are lower than those of the chosen standards and are being compared with savings from those standards.

DOE estimated the impacts for a policy scenario in which several States adopted provisions in their building codes that would require small electric storage water heaters to meet efficiency level 6 (2.0 EF). DOE assumed that such codes would affect 25 percent of the small electric storage water heaters in all new homes built in the United States in 2015 and that the percentage would increase linearly to 75 percent by 2045. (DOE did not attempt to define the specific geographic areas that would be affected.) In this scenario, those electric storage water heaters bought in new houses would meet the chosen standard level of 0.95 EF for rated small rated volume. DOE's NIA analysis assumes that in the base case some homes would have a water heater with 2.0 EF or greater in the absence of any amended standards or new policies. The assumed fraction of homes, including new homes, with heat pump water heaters in the base case is 5 percent in 2015, with the percentage increasing linearly to 17 percent by 2045.

15.4 IMPACTS OF NON-REGULATORY ALTERNATIVES

Figures 15.4.1 through 15.4.5 show the effects of each of the non-regulatory policy cases on market shares of units meeting the target level for gas-fired storage water heaters, electric storage water heaters, gas wall fan DHE, gas hearth DHE, and gas-fired pool heaters, respectively.

Figure 15.4.1 shows the effects of each non-regulatory policy on market penetration for gas-fired storage water heaters. Note that the market share of products that meet the target level is forecasted to increase over time in the base case (i.e., the case with neither standards nor non-regulatory policies). Relative to the base case, every policy case increases the market share of products that meet the target level. As shown in Figure 15.4.1, consumer rebates are most effective in increasing the market share of gas-fired storage water heaters that meet the target level, while early replacement is least effective. Recall that the standards (not shown in Figure 15.4.1) would result in a 100 percent market penetration of products that meet target efficiency levels.

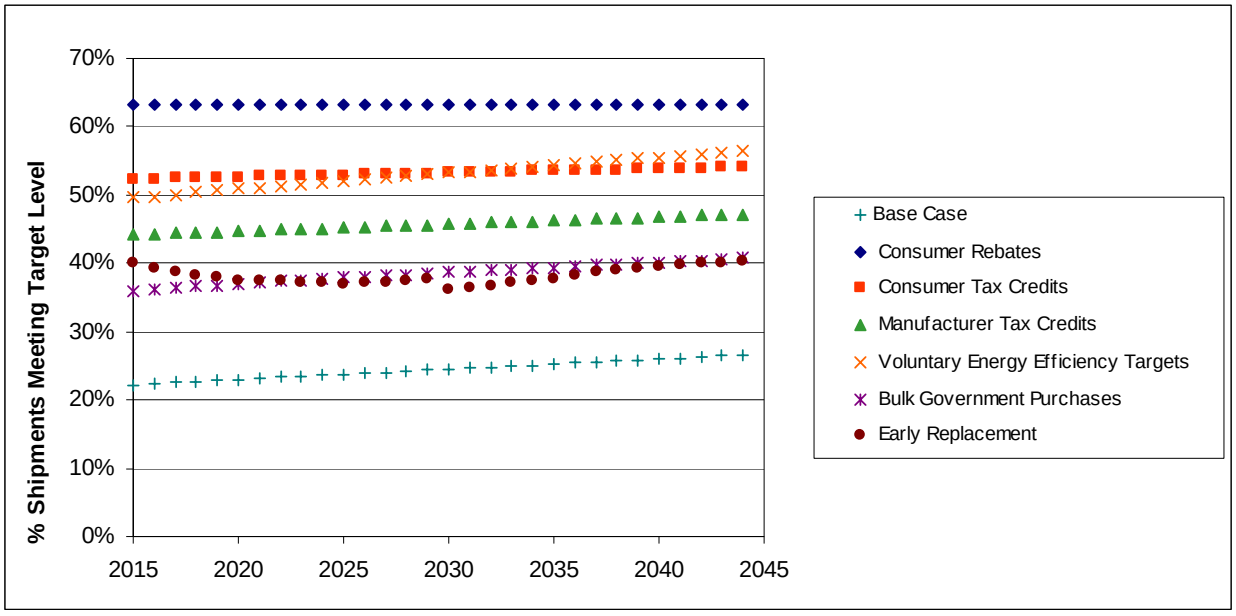

Figure 15.4.1 Market Penetration of Gas-Fired Storage Water Heaters Meeting Target Level in Policy Cases

Figure 15.4.2 shows the effects of each non-regulatory policy on market penetration for electric storage water heaters. The market share of products that meet the target level is forecasted to increase over time in the base case. Relative to the base case, all policy cases increase the market share of electric storage water heaters that meet the target level, with consumer rebates being the most effective and bulk government purchases the least effective. Recall that the chosen standards (not shown in Figure 15.4.2) would result in a 100 percent market penetration of products that meet the target efficiency level.

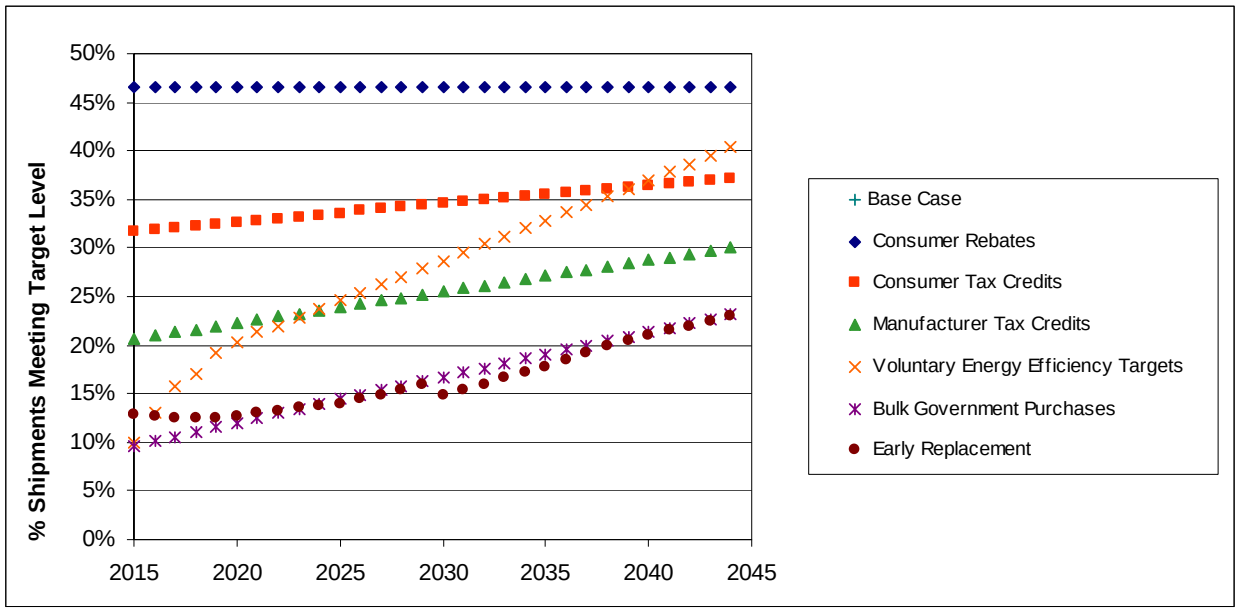

Figure 15.4.2 Market Penetration of Electric Storage Water Heaters Meeting Target Level in Policy Cases

Figure 15.4.3 shows the effects of each non-regulatory policy on the market penetration for gas wall fan direct heating equipment. In the base case, the market share of products that meet the target level is forecasted to be constant over time. Relative to the base case, all policy cases increase the market share of gas wall fan units that meet target efficiency levels, with consumer rebates being the most effective throughout the forecast period and early replacement the least effective. Recall that the chosen standards (not shown in Figure 15.4.3) would result in a 100 percent market penetration of products that meet the target efficiency level.

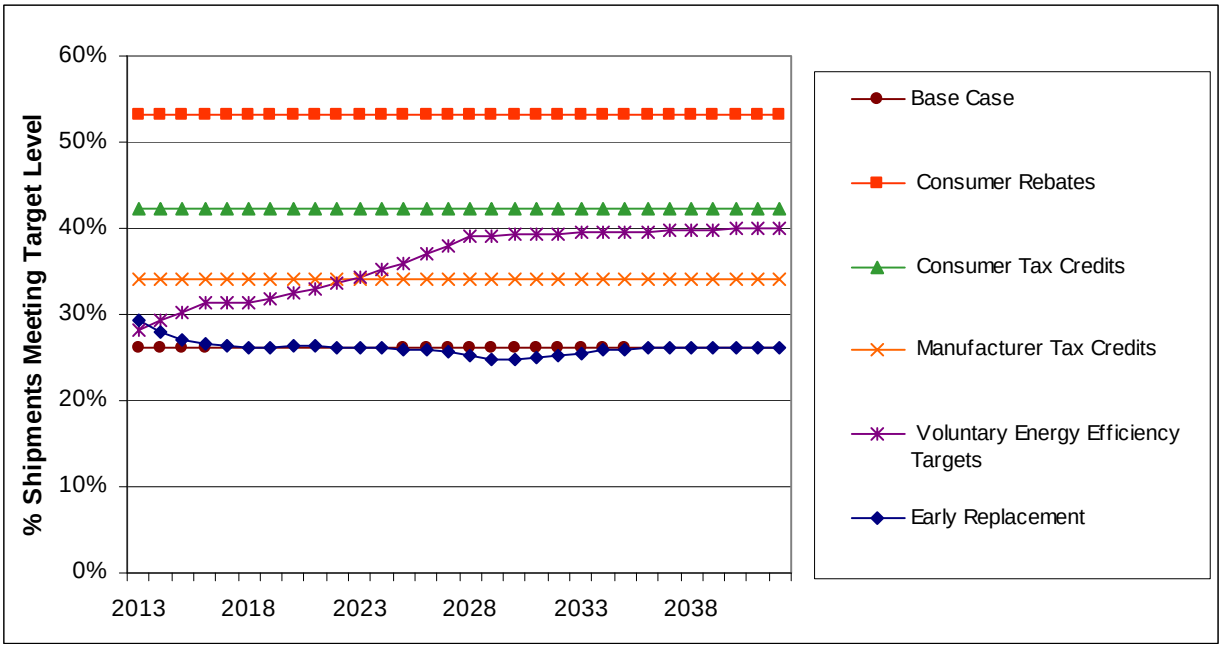

Figure 15.4.3 Market Penetration of Gas Wall Fan DHE Meeting Target Level in Policy Cases

Figure 15.4.4 shows the effects of each non-regulatory policy on the market penetration for gas hearth DHE. In the base case, the market share of products that meet the target level is forecasted to be constant over time. Relative to the base case, the non-regulatory policy cases increase the market share of gas hearth DHE that meet the target efficiency level. Consumer rebates are the most effective policy throughout the forecast period, and early replacement is the least effective. Recall that the chosen standards (not shown in Figure 15.4.4) would result in a 100 percent market penetration of products that meet the target efficiency level.

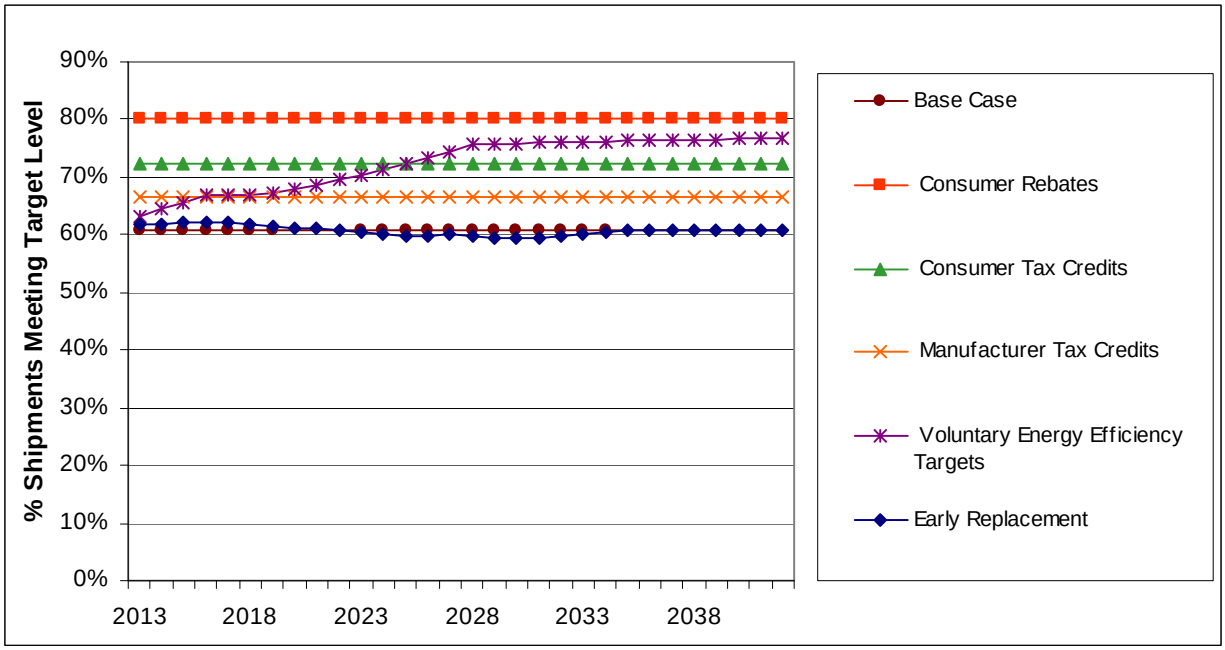

Figure 15.4.4 Market Penetration of Gas Hearth DHE Meeting Target Level in Policy Cases

Figure 15.4.5 shows the effects of each non-regulatory policy on the market penetration for gas-fired pool heaters. In the base case, the market share of products that meet the target level is forecasted to be constant over time. Relative to the base case, the non-regulatory policy cases except for early replacement increase the market share of gas-fired pool heaters that meet the target efficiency level. Consumer rebates are the most effective policy throughout the forecast period, and early replacement is the least effective. Recall that the chosen standards (not shown in Figure 15.4.5) would result in a 100 percent market penetration of products that meet the target efficiency level.

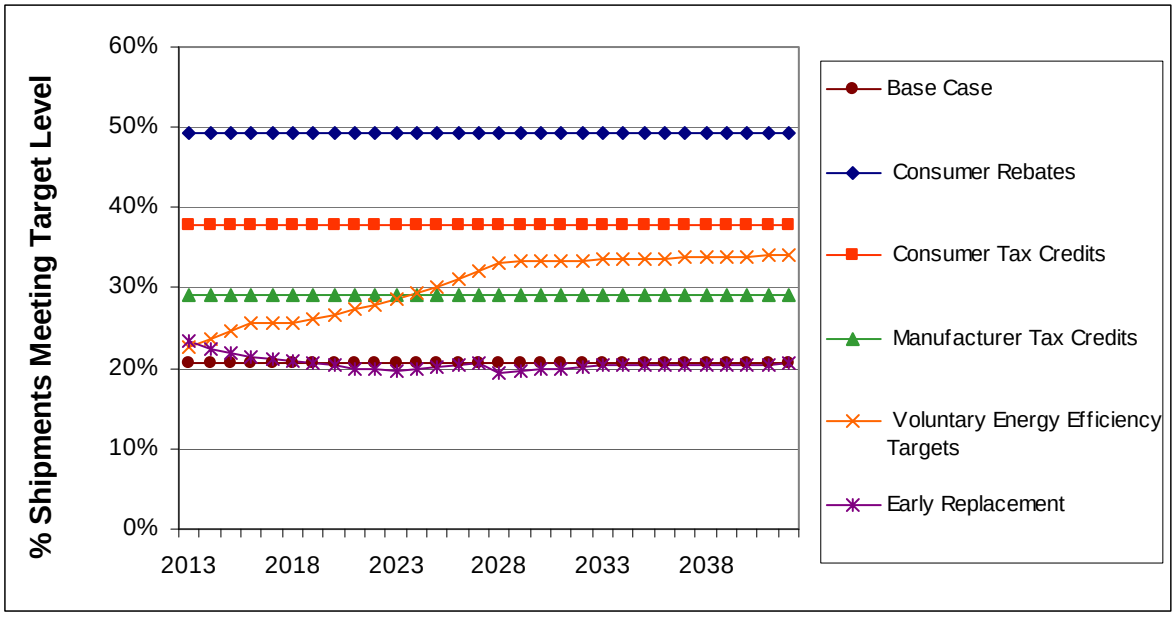

Figure 15.4.5 Market Penetration of Gas-Fired Pool Heaters Meeting Target Level in Policy Cases

15.5 SUMMARY OF RESULTS FOR NON-REGULATORY ALTERNATIVES

Tables 15.5.1 through 15.5.5 show the national energy savings and net present value (NPV) for each of the six non-regulatory policies analyzed in detail for residential water heaters, direct heating equipment, and pool heaters, where the target level for each policy equals the efficiency level in the corresponding chosen standard. Table 15.5.6 shows the national energy savings and NPV for the special case in which State building codes require high-efficiency electric storage water heaters (e.g. heat pump technology) for new homes.

The cases in which no regulatory action is taken with regard to residential water heaters, direct heating equipment, and pool heaters constitute the base cases (or "No New Regulatory Action" scenarios), in which energy savings and NPV are zero by definition. For comparison, the tables include the impacts of the chosen standards. Energy savings are given in quadrillion British thermal units (quads). The NPVs shown in Tables 15.5.1 through 15.5.5 are based on two discount rates (7 percent and 3 percent).

Table 15.5.6 shows the estimated national energy savings and NPV for the policy allowing States to incorporate requirements for high-efficiency electric water heaters into their building codes.

Note that the early replacement scenario produces a negative NPV all products at both a 7 percent and a 3 percent discount rate. The negative NPVs reflect the fact that energy cost savings occur during the first part of the analysis period, when the projected cost of electricity or gas is lowest. The negative NPV occurs when the projected growth rate of fuel prices exceeds the discount rate.

Table 15.5.1 Impacts of Non-Regulatory Alternatives for Gas-Fired Storage Water Heaters that Meet the Chosen Standard (TSL 5)

Policy Alternative	**Primary Energy Savings quads**	**Net Present Value* billion 2009$**	
		7% discount rate	3% discount rate
No New Regulatory Action	0.00	0.00	0.00
Consumer Rebates	0.21	0.05	0.55
Consumer Tax Credits	0.12	0.03	0.33
Manufacturer Tax Credits	0.06	0.01	0.17
Voluntary Energy Efficiency Targets	0.12	0.05	0.38
Early Replacement	0.001	-0.03	-0.05
Bulk Government Purchases	0.003	0.004	0.01
Chosen Standards at Efficiency Level 2	0.81	0.27	2.37

* Net present value (NPV) is the value of a time series of costs and savings. DOE determined the NPV from 2015 to 2045.

Table 15.5.2 Impacts of Non-Regulatory Alternatives for Electric Storage Water Heaters that Meet the Proposed Standard (TSL 5)

Policy Alternative	Primary Energy Savings quads	Net Present Value* billion 2009$	
		7% discount rate	3% discount rate
No New Regulatory Action	0.00	0.00	0.00
Consumer Rebates	0.53	0.19	1.50
Consumer Tax Credits	0.32	0.12	0.90
Manufacturer Tax Credits	0.16	0.06	0.45
Voluntary Energy Efficiency Targets	0.17	0.29	0.99
Early Replacement	0.003	-0.05	-0.08
Bulk Government Purchases	0.003	0.004	0.01
Chosen Standards at Efficiency Level 5	1.67	1.03	5.84

* Net present value (NPV) is the value of a time series of costs and savings. DOE determined the NPV from 2015 to 2045.

Table 15.5.3 Impacts of Non-Regulatory Alternatives for Gas Wall Fan DHE that Meet the Chosen Standard (TSL 2)

Policy Alternative	Primary Energy Savings quads	Net Present Value* billion 2009$	
		7% discount rate	3% discount rate
No New Regulatory Action	0.00	0.00	0.00
Consumer Rebates	0.004	0.007	0.018
Consumer Tax Credits	0.002	0.004	0.011
Manufacturer Tax Credits	0.001	0.002	0.002
Voluntary Energy Efficiency Targets	0.001	0.003	0.002
Early Replacement	<0.0001	-0.000001	-0.000004
Bulk Government Purchases†	NA	NA	NA
Proposed Standards at Efficiency Level 3	0.01	0.03	0.07

* Net present value (NPV) is the value of a time series of costs and savings. DOE determined the NPV from 2013 to 2043.

† DOE did not evaluate the bulk government purchase alternative for gas wall fan direct heating equipment because the market share associated with publicly owned housing is minimal.

Table 15.5.4 Impacts of Non-Regulatory Alternatives for Gas Hearth DHE that Meet the Chosen Standard (TSL 2)

Policy Alternative	Primary Energy Savings quads	Net Present Value* billion 2009$	
		7% discount rate	3% discount rate
No New Regulatory Action	0.00	0.00	0.00
Consumer Rebates	0.04	0.10	0.23
Consumer Tax Credits	0.02	0.06	0.14
Manufacturer Tax Credits	0.01	0.03	0.07
Voluntary Energy Efficiency Targets	0.02	0.05	0.14
Early Replacement	<0.001	-0.00006	-0.0001
Bulk Government Purchases†	NA	NA	NA
Proposed Standards at Efficiency Level 1	0.19	0. 50	1.21

* Net present value (NPV) is the value of a time series of costs and savings. DOE determined the NPV from 2013 to 2043.

† DOE did not evaluate the bulk government purchase alternative for gas hearth DHE because the market share associated with publicly owned housing is minimal.

Table 15.5.5 Impacts of Non-Regulatory Alternatives for Pool Heaters that Meet Proposed Standards (TSL 2)

Policy Alternative	Primary Energy Savings quads	Net Present Value* billion 2009$	
		7% discount rate	3% discount rate
No New Regulatory Action	0.00	0.00	0.00
Consumer Rebates	0.006	0.01	0.03
Consumer Tax Credits	0.003	0.006	0.02
Manufacturer Tax Credits	0.002	0.003	0.01
Voluntary Energy Efficiency Targets	0.002	0.004	0.01
Early Replacement	<0.001	-0.0003	-0.0005
Bulk Government Purchases†	NA	NA	NA
Chosen Standards at Efficiency Level 5	0.02	0.04	0.11

* Net present value (NPV) is the value of a time series of costs and savings. DOE determined the NPV from 2013 to 2043.

† DOE did not evaluate the bulk government purchase alternative for pool heaters because there is no market share associated with publicly owned housing.

Table 15.5.6 shows the estimated national energy savings and NPV for electric storage water heaters under the chosen standards. The table also shows the additional national energy savings that would result from the policy allowing States to incorporate requirements for high-efficiency electric water heaters in building codes, as well as the net present value of additional benefits to consumers. In this case, those consumers are the purchasers of new homes that have electric water heaters that have an EF of 2.0 (e.g. heat pump technology).

Table 15.5.6 Impacts of Policy Allowing States to Incorporate Requirements For High-Efficiency Electric Storage Water Heaters In Building Codes

Policy Alternative	**Primary Energy Savings quads**	**Net Present Value billion 2009$**	
		7% discount rate	3% discount rate
No New Regulatory Action	0.00	0.00	0.00
Chosen Standards at Efficiency Level 5 for small water heaters and Level 6 for large water heaters (Electric Storage Water Heaters)	1.67	1.03	5.84
Chosen Standards AND Policy Allowing States to Require Higher-Efficiency Electric Storage Water Heaters in New Homes	2.18	1.23	7.35

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